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PAPERS AND PROCEEDINGS OF THE 15th ANNUAL MEETING

of the

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HELD JOINTLY WITH THE UTAH MOSQUITO
ABATEMENT ASSOCIATION

Salt Lake City, Utah, April 12-15, 1959

PART II

THE 1958 ENCEPHALITIS OUTBREAK IN NORTHERN UTAH.

I. HUMAN ASPECTS

A. A. JENKINS¹ AND RUDOLF DONATH²

During the summer and fall of 1958 there was an epidemic of western equine encephalitis (WEE) in northern Utah. This was the largest laboratory-confirmed outbreak of this disease among humans in the history of the state. For a number of years, people interested in disease control have recognized that Utah has the potential for a WEE outbreak; namely, the reservoir, the vector, and the susceptible population. However, only a few cases of this disease had been reported in the last several years.

In 1957, a physician in Weber County reported clinical cases of WEE, two of which were laboratory confirmed. An older physician in Box Elder County informed us that they had had quite an extensive outbreak of encephalitis in Tremonton and vicinity in 1936, and that there were still a few people who have residual effects of the disease.

First knowledge of an encephalitis outbreak in Utah in 1958 was on August 12th,

when physicians from Box Elder County reported clinical cases. Subsequently, other clinical cases were reported by physicians in Box Elder, Weber, Davis, Salt Lake, and other counties.

After the first clinical case was reported from Box Elder County, all physicians in the County were notified of the possible outbreak, and of laboratory specimens needed for confirmation. Through the *Utah Medical Bulletin*, all physicians of the state were likewise alerted and given information concerning the reservoir, vector, signs and symptoms, and particularly specimens needed for laboratory study. Emphasis was placed on obtaining acute and convalescent blood specimens in cooperation with physicians and hospital personnel, since this is one of the best methods for confirmation of the disease.

An analysis of the 48 cases of encephalitis in this outbreak shows that 36 were confirmed by a fourfold or greater increase in titer between acute and convalescent blood specimens; 11 by a single high convalescent titer along with compatible signs and symptoms in individuals living in the area; and 1 case (the only confirmed fatality) by laboratory study of brain tissue.

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The first known case had onset June 15, 1958, and the last case September 21, 1958. There were 38 males and 10 females who had the infection. Of the 48 cases, 31 were hospitalized while 17 were treated at home. By date of onset the peak of this outbreak was reached during the second week of August when 12 cases occurred.

Signs and symptoms in infants and young children consisted of irritability, localized twitching of face and extremities, fever up to 104° F., neck rigidity (50%), tense fontanels, and 100-200 cells, predominately lymphocytes, in the spinal fluid. Some adults had severe headache, lethargy, and vomiting.

In order to obtain data on human sub-clinical infection rates from an epidemic area, a serum survey was conducted in the general area of Tremonton, Utah, during the period from November 18 to 21, 1958. The following is a preliminary summary of this survey.

In all 268 sera were collected, including 30 from infants, 30 from adults (mothers of these infants), and the rest mostly from 4th and 5th grade students. Aliquots of 197 sera were tested for WEE hemagglutination-inhibition antibodies in both the Greeley, Colorado, and the Montgomery, Alabama, laboratories of the Communicable Disease Center. The results from the two laboratories, summarized in Table 1, were in very close agreement.

Although the total numbers of WEE-positive serum specimens from infants and adults were too small to measure accurately the differences in infection rates, the results do tend to indicate a progressive increase in the rates from infants to adults. The over-all infection rates are in line with those obtained from other areas where WEE is endemic, and confirm the considerable amount of inapparent infection which usually occurs in such areas.

TABLE 1.—Summary of laboratory tests (HI) for western encephalitis antibodies on human sera collected in northern Utah, November 1958

Age group	Total number of sera tested	Total number of positives	Percent positive
Infants	25	1	4.0
School-children*	145	13	9.0
Adults	27	3	11.1
Totals	197	17	8.6

* Fourth and fifth grades.

UTAH MOSQUITO ABATEMENT ASSOCIATION

Sixty per cent of the people in the state of Utah are now living within the boundaries of organized mosquito abatement districts.

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THE 1958 ENCEPHALITIS OUTBREAK IN NORTHERN UTAH.

2. INFECTION RATES IN BIRDS, MAMMALS, AND MOSQUITOES

LEO A. THOMAS¹ AND JAMES V. SMITH²

During an outbreak of encephalitis in northern Utah in the late summer of 1958, efforts were made to determine infection rates in birds, mammals, and mosquitoes from August 15 to September 9. The results of this study are reported here.

Figure 1 shows the area involved from Preston, Idaho, to Payson, Utah, where collections of mosquitoes or blood specimens were obtained during the study. Intensive work was limited to the area between Preston, Idaho, and Brigham City, Utah, but a few blood specimens were collected much further south at Richfield, Utah.

METHODS

Prevalence of infection in mosquitoes was determined by making collections of mosquitoes at various localities, sorting them into species, and testing for virus infection by inoculation in appropriate laboratory animals. The agents isolated were identified by the standard neutralization test.

In addition to virus isolations, serological techniques were employed to determine the incidence of infection in birds, mammals, and humans. The tests used were hemagglutination-inhibition (HI), complement-fixation (CF), and virus neutralization. The HI and neutralization tests detect both recent and past infections; the CF test, recent infection.

RESULTS

INCIDENCE OF INFECTION IN MOSQUITOES.

Only 7 of 80 pools of 3,741 *Culex tarsalis*

collected from the entire study area yielded western equine encephalitis (WEE) virus and none yielded St. Louis encephalitis (SLE) virus. The over-all infection rate in *C. tarsalis* was at least 1 in 534 (0.2%).

Data on incidence of infection in *C. tarsalis* are presented in Table 1. Five of 26 pools of 1,304 *C. tarsalis* collected at Bothwell were positive for WEE virus, an infection rate of at least 1 in 261 (0.4%). The infection rate at Wellsville was at least 1 in 150 (0.7%) and at Brigham City at least 1 in 1,115 (0.09%).

In addition, 3 *Culiseta inornata* collected at Fielding, 100 *C. inornata* collected at Wellsville, and 50 *Culex pipiens* collected at Bothwell were tested for virus. No isolations were made from these mosquitoes.

ISOLATION OF WEE VIRUS FROM MAN.

An agent was isolated from brain tissue, obtained upon autopsy of a 2-month-old infant from Fielding, and was identified as WEE virus.

SEROLOGY. The results of testing human, horse, and chicken sera for the presence of HI, CF, or neutralizing antibodies are shown in Table 2. The sera examined in one test are not necessarily the same sera examined in another test. Thirty-two human sera, mostly from close associates of clinical encephalitis patients, were collected from an area extending from Smithfield to Payson, Utah. Three sera (9%) had neutralizing antibodies but none of the sera showed CF antibodies. The positive sera were from Smithfield and Tremonton. None of the sera was tested for HI antibodies.

Horse sera were tested for HI, CF, and neutralizing antibodies. Eighteen of 20 (90%) had HI antibodies, 37 of 67 (55%) had CF antibodies, and 62 of 71 (87%) had neutralizing antibodies. The

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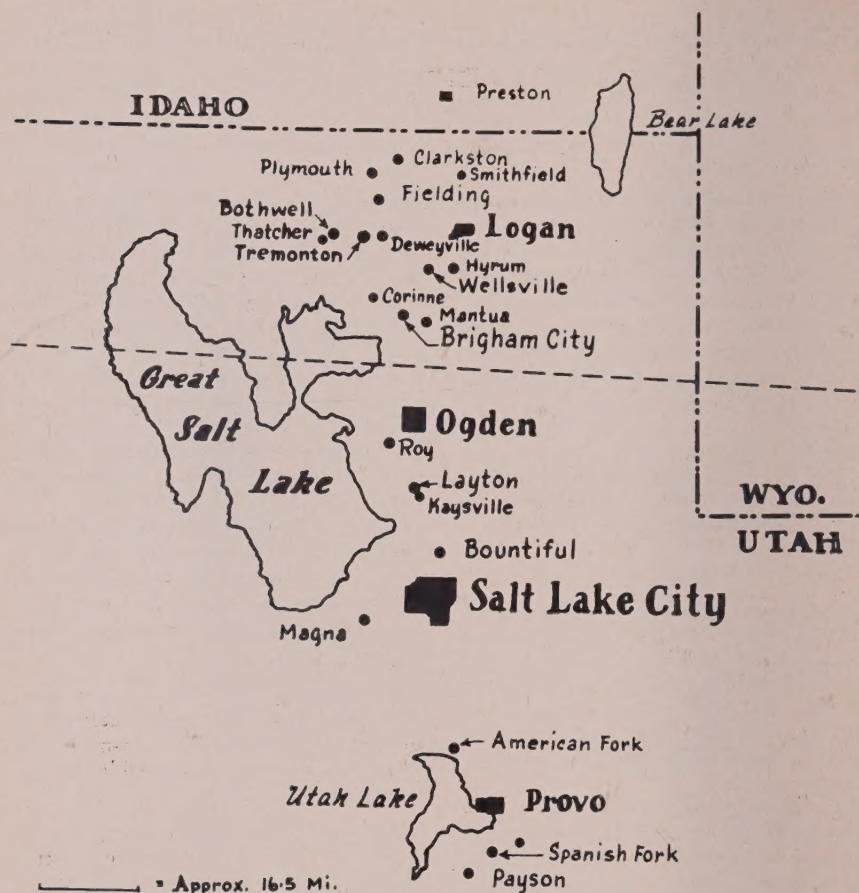


FIG. 1.—Northern Utah, showing area involved in encephalitis outbreak of 1958.

positive sera were collected in an area extending from Plymouth to Richfield.

Sera of chickens less than a year old were collected in a much more limited area. The incidence of HI antibodies was 28 in 271 sera (10%) and of neutralizing antibodies 8 in 50 (16%). These sera were not tested for CF antibodies. The infection rate, as shown by HI antibodies, was 24% at Bothwell (21 of 88), but it was only 2% at Preston, Idaho (1 of 49), 4% at Clarkston (3 of 84), and 6% (3 of 50) in the Wellsville-Hyrum area.

Sera from one meadowlark and one sparrow collected at Mantua and from 25 English sparrows collected at Bothwell were tested for neutralizing antibodies with negative results.

DISCUSSION

The isolation of WEE virus from mosquitoes and the serological evidence of recent infection with WEE virus in horses, and in chickens less than a year old, and the isolation of the virus from the brain

TABLE 1.—Summary of virus isolation from *Culex tarsalis* mosquito pools collected in northern Utah, 1958

Location	Number of mosquitoes tested	Number of pools tested	Number of pools positive for WEE virus
Thatcher	100	2	0
Bothwell	1304	26	5
Tremonton	14	2	0
Fielding	28	1	0
Deweyville	100	2	0
Wellsville	150	3	1
Corinne	311	5	0
Mantua	11	1	0
Brigham City	1,115	25	1
Roy	50	1	0
Kaysville	100	2	0
Bountiful	350	7	0
Magna	50	1	0
Spanish Fork	58	2	0
Total	3741	80	7

TABLE 2.—Antibody titers for WEE virus, Idaho and Utah, 1958

Blood source	HI			C-F			Neutralization		
	No. tested	No. pos.	Percent pos.	No. tested	No. pos.	Percent pos.	No. tested	No. pos.	Percent pos.
Human	—	—	—	32	0	0	32	3	9
Horse	20	18	90	67	37	55	71	62	87
Chicken	271	28	10	—	—	—	50	8	16

of a child demonstrate the nature of the disease which was present in the area in 1958.

The field data indicate a very low infection rate in the *C. tarsalis* population in northern Utah. It may be significant that the mosquito infection rate at Bothwell, in the center of the outbreak, was 1:261 whereas at Brigham City it was only 1:1,115. All of the mosquito collections were made between August 15 and September 9, and thus, it seems likely that the incidence of infection detected in the mosquito population may not have been representative of that prior to, or during the peak of, the outbreak. Since the mosquitoes collected may have emerged late and, therefore, had little opportunity to acquire infection, the observed infection rate may be lower than that present earlier in the outbreak.

HI and neutralizing antibodies are known to persist for a considerable length of time following virus infection, while CF antibodies, for the most part, persist usually for less than a year. Of the 32 human sera (Table 2), mostly from close associates of clinical encephalitis patients, 3 were shown to have WEE neutralizing antibodies. Since none of the 32 sera had CF antibodies, the 3 which had neutralizing antibodies probably were from individuals who had been infected in previous years. As expected, this suggests that there was very little, if any, inapparent infection in persons associated with clinically ill patients in this outbreak.

Examination of horse sera was useful for determining the geographic extent and incidence of infection during the outbreak. The data on antibodies in horses (Table 2) indicate either previous or recent exposure

to WEE virus. Approximately 90% of the horses had neutralizing or HI antibodies which might be due either to past or to recent infection. The CF test indicated a recent infection in approximately 55% of horses examined.

Data from chicken sera (Table 2) show evidence of recent infection in chickens since all of the chickens tested were less than 1 year old. Two to 24% of chickens in different areas had HI antibodies and about 16% in the entire area had neutralizing antibodies against WEE. Results of HI tests on sera collected in 1957 from the same areas and from approximately the same number of chickens showed no significant difference in the percentage of chickens showing antibodies, though the rates were slightly higher in 1958. Infection rates obtained from testing these chicken sera collected in 1957 and 1958 for the presence of HI antibodies against St. Louis virus were 0% and approximately 6 percent, respectively.

ACKNOWLEDGMENTS

In the course of these studies we worked under the auspices of the Utah State Department of Health. We are much indebted to veterinarians Dr. J. T. Simper, Brigham City, Dr. Robert Poulson, Tremonton, and Dr. C. H. Porter of

Spanish Fork for professional help and information on disease in horses. Dr. Arley Flinders, City Health Officer at Ogden, Utah, was very helpful to us and also was active in promoting mosquito control activities within his district. Dr. William L. Jellison of the Rocky Mountain Laboratory gave advice and help in the carrying out of field studies. Our limited tests on human sera were made in cooperation with Dr. Rudolph Donath, Communicable Disease Center, U. S. Public Health Service, Atlanta, Georgia. Numerous farmers in Utah assisted by permitting us to bleed their horses and chickens, often at considerable inconvenience to themselves.

SUMMARY

During the 1958 outbreak of encephalitis in northern Utah, western equine encephalitis virus was isolated from human tissue and from mosquitoes. There was no evidence of recent infection in humans associated with clinical cases. Serological tests indicated recent exposure of horse and chicken populations to the virus. The few wild bird sera examined did not show evidence of infection. The highest infection rates in both mosquitoes and chickens occurred in the center of the human outbreak.

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THE 1958 ENCEPHALITIS OUTBREAK IN NORTHERN UTAH.

3. MOSQUITO POPULATIONS IN RELATION TO THE OUTBREAK

EAG

DON M. REES,¹ LOUIS J. OGDEN,² GLEN C. COLLETT,³ JAY E. GRAHAM⁴

INTRODUCTION. In referring to western equine encephalitis (WEE), Hess and Holden (1958) state: "There seems to be little question that *Culex tarsalis* is the primary vector in the sylvan transmission cycle as well as in the endemic chain of infection in the western United States. . . . Species other than *C. tarsalis* are, however, considered to be of secondary importance." It is justifiably concluded by these same authors that: "With a given mosquito infection rate, the chances for human infection will be correlated directly with the vector's biting or attack rates on man. These attack rates are obviously related, in turn, to mosquito population densities." It appears, therefore, that *C. tarsalis* mosquitoes in Utah are the most important vectors to man of WEE virus, and that an increase in the population density of infected *C. tarsalis* mosquitoes would increase the rate of biting on man, with an accompanying increase in the number of people acquiring this disease.

In this paper, the *C. tarsalis* mosquito population in northern Utah in 1958, when an epidemic of encephalitis occurred, is compared with populations of this species during the years immediately preceding the outbreak. In addition, consideration is given to climatologic factors that may have influenced the *C. tarsalis* population in northern Utah during these same years.

Mosquito larval records from the South Salt Lake County Mosquito Abatement District and mosquito light trap collection

records from the Salt Lake City and the Weber County Mosquito Abatement Districts were used in preparing this report.

The climatologic data were obtained from the U. S. Weather Bureau and the U. S. Geological Survey.

LARVAL COLLECTIONS. Larval collection records presented in Figure 1 show the numbers of different mosquito-producing habitats found during the 1956-1958 mosquito breeding seasons that contained larvae of the three principal species of mosquitoes. It is evident that there was a significant and successive build-up each year in the number of pools containing *C. tarsalis* larvae. The increase in the number of pools in 1958 over the previous 2 years started in April and more than doubled in May and June, then continued during the remainder of the season far above the numbers reported in the other 2 years. The increase in the number of pools containing *C. tarsalis* larvae in 1958 was approximately 230 percent over 1957 and 440 percent over 1956. This increase in number of pools of *C. tarsalis* larvae was greatest during July and August.

The number of pools containing *A. dorsalis* in 1958 was somewhat greater than in 1956 and 1957, but this increase was nowhere near that observed for *C. tarsalis*. The number of pools containing *C. inornata* during the encephalitis transmission season (July-August) was not much greater in 1958 than in 1956 and 1957, although there was a marked increase in May and June over the previous 2 years.

LIGHT TRAP COLLECTIONS. Six New Jersey type mosquito light traps were operated 2 nights each week at the same location in the Salt Lake City District from May through mid-October during 1956-1958. In Weber County, 6 traps

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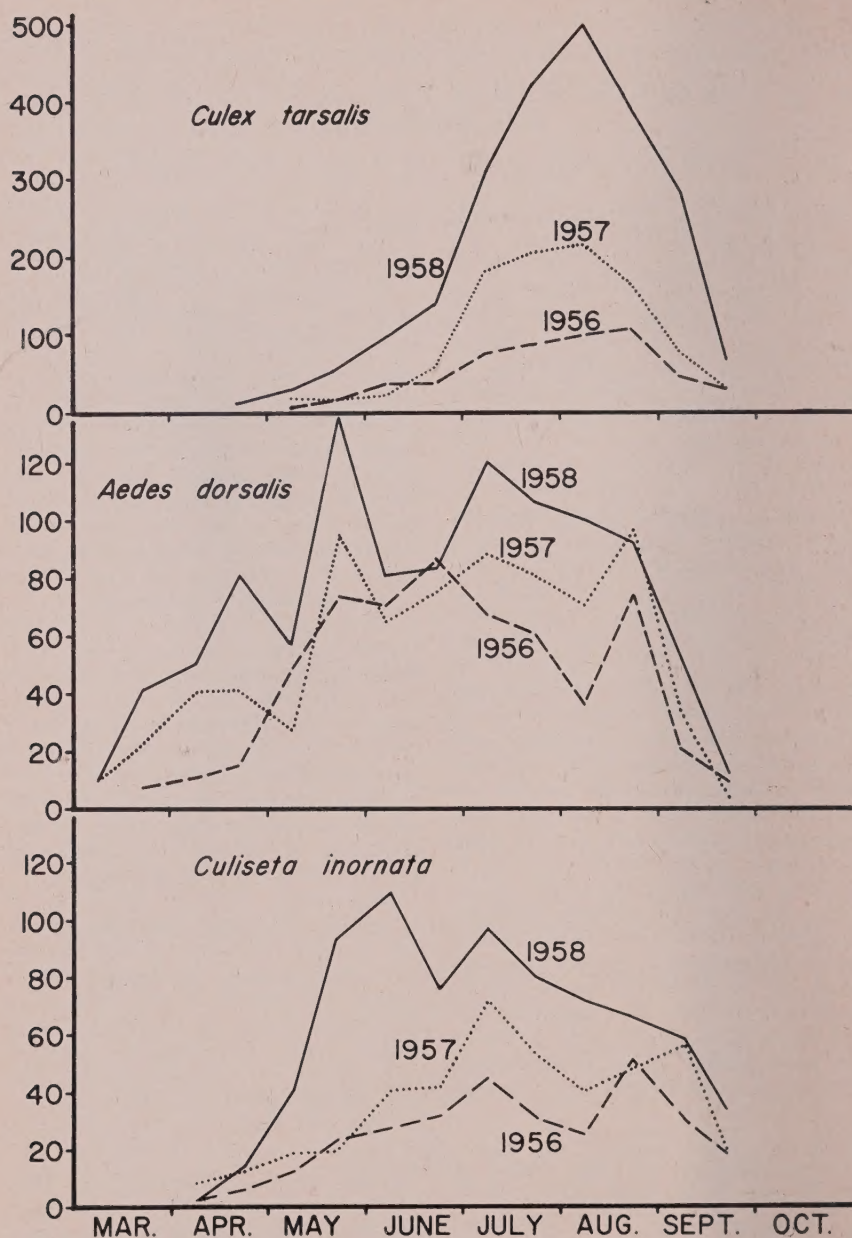


FIG. 1.—Numbers of habitats in South Salt Lake County Mosquito Abatement District that contained larvae of *Culex tarsalis*, *Aedes dorsalis*, and *Culiseta inornata* during the 1956, 1957, and 1958 mosquito breeding seasons.

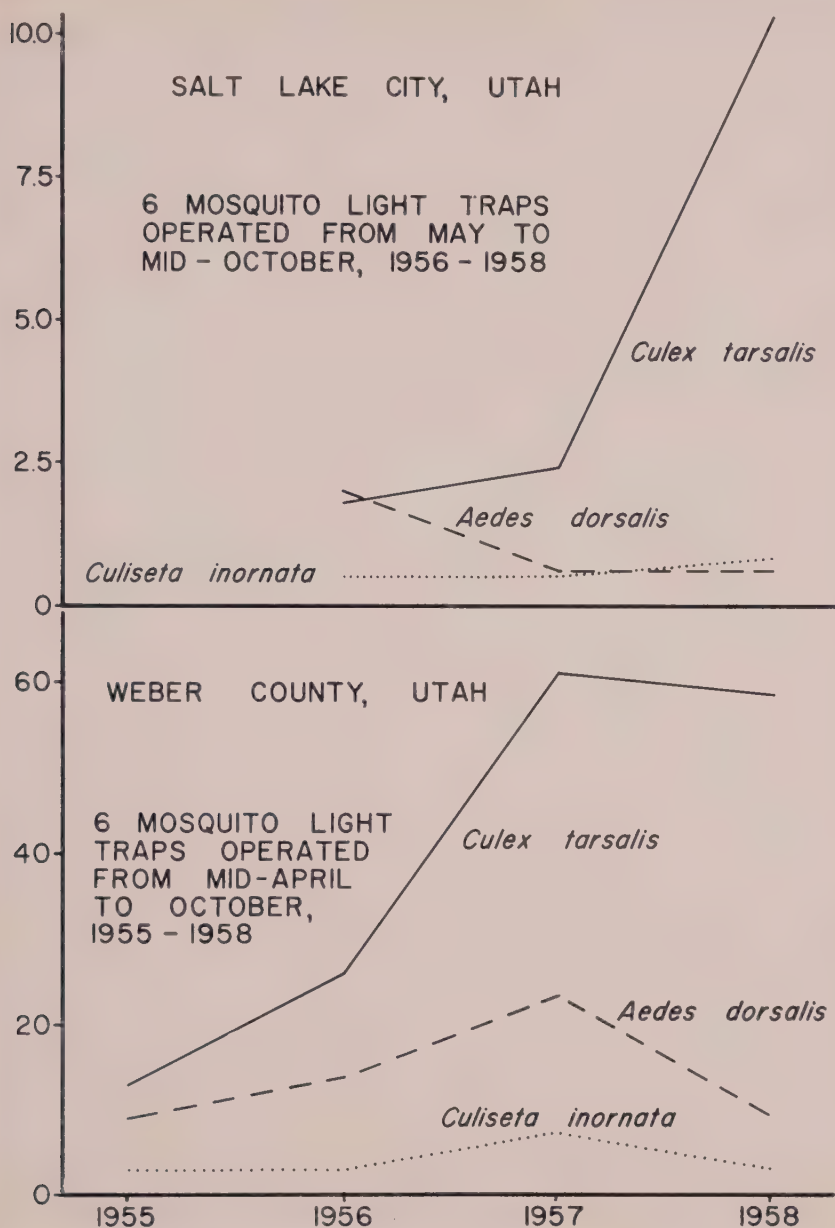


FIG. 2.—Average numbers of adult mosquitoes collected per trap night in 2 areas of northern Utah during the 1955, 1956, 1957, and 1958 seasons.

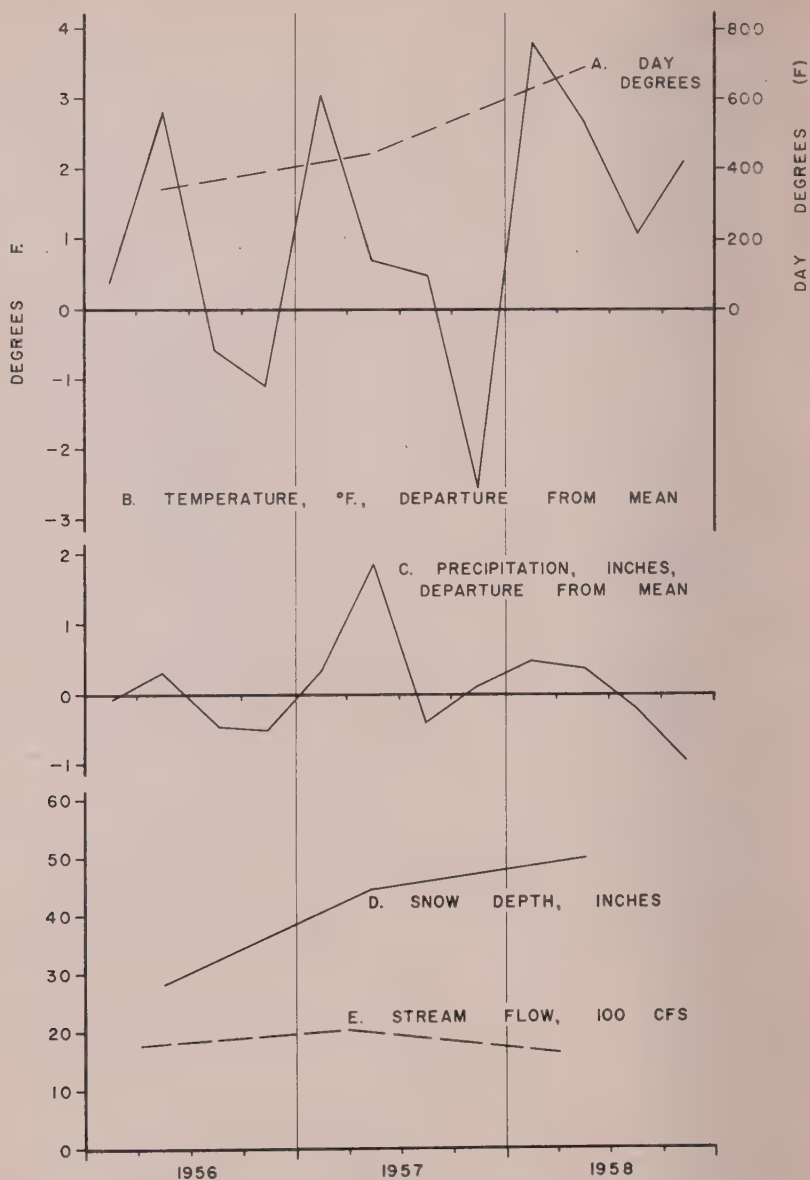


FIG. 3.—Comparative weather data for northern Utah during 1956-1958: (A) Day degrees F. above normal (algebraic sum of daily deviations from long-term means) for first 9 months of each year, Corinne, Box Elder County, Utah; (B) Departures from long-term mean temperatures, degrees F., Corinne, Utah; (C) Departures from long-term mean precipitation, inches, Corinne, Utah; (D) Average daily snow depth, April-June, Brighton, Salt Lake County, Utah; (E) Average daily flow of Bear River in hundreds of cubic feet per second for first 6 months of each year, Collingston Station, U. S. Geological Survey, Water Resources Division, Box Elder County, Utah.

were operated 7 nights each week at the same locations from mid-April through September during 1955-1958. The average number of adult *C. tarsalis*, *A. dorsalis*, and *C. inornata* collected per trap night is shown in Figure 2. The *C. tarsalis* population in the Salt Lake City District in 1958 was more than 4 times the average for the previous 2 years, which is in line with the larval data from the South Salt Lake County District. The increase first appeared in July, reached a peak in August, and then slowly declined in September. Thus, in 1958 there was a tremendously greater number of *C. tarsalis* present during the encephalitis transmission season than during the previous non-epidemic years. In contrast to the *C. tarsalis* population, light trap collections of *A. dorsalis* and *C. inornata* during 1958 showed no increases over the previous years.

In Weber County, high *C. tarsalis* populations were recorded in both 1957 and 1958, the average numbers being 2 to 3 times those of the previous 2 years (Fig. 2). The populations of *A. dorsalis* and *C. inornata*, as recorded by the Weber County light traps, increased slightly in 1957 when compared with the previous seasons, but decreased in 1958.

CLIMATOLOGIC DATA. The average temperature for the first 9 months of 1958 was considerably above that of the same period during the previous 2 years, as reflected by the day degrees above the long-term average (Fig. 3, A). This increase was apparent during each of the first 3 quarters of the year (Fig. 3, B). Thus 1958 provided milder winter conditions and an earlier, warmer spring than the previous years, factors which should favor high production of *C. tarsalis*; furthermore, the higher summer temperatures may well have provided more favorable conditions for encephalitis transmission.

Precipitation was above normal during the first quarter and below normal during the third quarter in both 1957 and 1958 (Fig. 3, C). In both years there was, therefore, adequate water for spring mosquito breeding and a dry summer, which many workers believe is favorable for encephalitis transmission.

The average snow depth during the period April-June showed a progressive increase from 1956 through 1958 (Fig. 3, D). This would indicate an abundant supply of water for irrigation in 1958. This usually encourages excessive use of irrigation water, which again favors the production of *C. tarsalis*.

The stream flow data (Fig. 3, E) do not reflect any significant changes in 1958. This is undoubtedly due to the fact that the excess water is stored and the stream flow regulated by the various impoundments on the Bear River above Collingston, before it reaches the area of the 1958 outbreak.

In summary, the year 1958 in northern Utah was characterized by an unusually warm and wet winter and spring, followed by a hot dry summer with an abundance of irrigation water. It may well be that these are the weather conditions which are most important in providing favorable conditions for outbreaks of western equine encephalitis.

SUMMARY. On the basis of adult and larval collections, populations of *C. tarsalis* in northern Utah were much greater in 1958 than in the previous 2 years. This same year was characterized by an unusually warm and wet winter and spring, followed by a hot, dry summer with an abundance of irrigation water.

Reference Cited

- HESS, A. D., and HOLDEN, PRESTON. 1958. The natural history of the arthropod-borne encephalitides in the United States. *Ann. N. Y. Acad. Sci.* 70 (art. 3):294-311.

COMPARISON OF ARTIFICIAL SHELTERS AND LIGHT TRAPS FOR MEASUREMENT OF *CULEX TARSALIS* AND *ANOPHELES FREEBORNI* POPULATIONS

EDMOND C. LOOMIS AND EUGENE J. SHERMAN

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Various types of shelters have been used for collecting adult mosquitoes. The term "artificial resting unit" (A.R.U.) was used by Loomis and Aarons (1953) to designate a man-made shelter used only for attracting and collecting mosquitoes. This is in contrast to an artificial resting place which is a man-made shelter used primarily for purposes other than attracting or collecting mosquitoes.

Artificial resting units have been used by many investigators since their introduction by Ross (1910). Numerous workers found that small wooden frames covered with mosquito netting (James, 1914) or earthlined boxes or kegs (Russell and Santiago, 1934; Smith, 1942) were suitable for collecting anophelines. Goodwin (1942) found that a red, cubical, wooden box of one cubic foot capacity was satisfactory for collecting *Anopheles quadrimaculatus* Say. Schoof (1944) described a 3' x 3' x 6' box used in malaria control programs during World War II.

In California, several types of artificial resting units have been used to follow seasonal changes in size of adult mosquito populations. Portable "privy-type" shelters (6'-6" x 4' x 4') (Snow, 1949) were tested for the collection of *Culex* species. The red box designed by Goodwin was first used in California at the Bakersfield Encephalitis Laboratory for collecting *Culex tarsalis* Coquillett. Loomis and Aarons (1953) reported that the red box was more practical than other types tested because of its durability, portability, and ease of inspection. Hayes *et al.* (1958), however, indicated that any of their sampling methods (red boxes, carbon dioxide bait trap, light trap, natural shelters) was

adequate for measuring *C. tarsalis* populations and the method of choice was dependent upon the objective of the study. Loomis and Green (1959) found that counting *Culex* mosquitoes in cardboard boxes placed on the walls inside poultry houses was easier and required less time than counting or collecting in the houses.

The objectives of the present study were to determine the reliability of red boxes for measuring population trends of *C. tarsalis* and *Anopheles freeborni* Aitken and to compare these results with those based on light traps.

METHODS. The study was conducted in a 70-square-mile agricultural area of the Sacramento Valley. The area was bordered by the Feather River to the east and the Sutter Buttes (elevation, 2680 feet) to the west. The principal crops in the area were rice, peaches, prunes, almonds, and permanent pastures.

The A.R.U. used in this study was the red box described by Goodwin (*op. cit.*). The boxes were cubical, of one cubic foot volume, and made of quarter inch, exterior plywood painted on all sides with red enamel. A box was utilized in each of six locations in 1955. In 1956 boxes were placed at five of the six locations used in 1955 and at four additional ones. For comparative purposes extra boxes were placed in three of the nine locations studied in 1956. In both years all but two of the locations used were rural.

The boxes were placed on the ground in continuously shaded areas with the openings to the lee of prevailing winds. Mosquitoes were counted and identified with the aid of a flashlight. The counts were made clockwise starting on the left

wall of the box and the back wall was counted last. The total number of each species was recorded in 1955 but in 1956 the total count was followed by a count of the males of each species. *C. tarsalis* was identified by its banded legs and unspotted wings and *A. freeborni* by its unbanded legs and spotted wings. In 1956 the accuracy of counting was checked by chloroforming all mosquitoes in the box and recounting them in the laboratory.

Cracken, *Aedes nigromaculis* (Ludlow), *Culiseta incidens* (Thomson), *Culex erythrothorax* Dyar, *Aedes sierrensis* (Ludlow), *Anopheles punctipennis* (Say), and *Orthopodomyia californica* R. Bohart.

A comparison of field and laboratory counts of *C. tarsalis* in boxes is shown in Table 1. For *C. tarsalis* the difference in counts was greatest when more than 200 specimens were present, but the proportional error was greatest when there were

TABLE 1.—Actual and visual mean weekly counts of *C. tarsalis* and *A. freeborni* (both sexes) in Red Boxes, Sacramento Valley, California, 1956

<i>C. tarsalis</i>			<i>A. freeborni</i>		
Actual count	Visual estimate	Count minus estimate	Actual count	Visual estimate	Count minus estimate
288	271	+17	28	31	-3
181	181	0	25	26	-1
95	99	-4	19	19	0
85	86	-1	18	18	0
65	69	-4	12	11	+1
37	45	-8	9	10	-1
25	25	0	7	7	0
21	23	-2	6	5	+1
15	17	-2	4	4	0

Source: State of California, Department of Public Health, Bureau of Vector Control Records.

The boxes were inspected from one to four times each week in 1955 and three to five times each week in 1956. The inspections were usually made in the morning.

An American Model light trap was used to study the mosquito population at one urban location. The trap was suspended five feet above the ground and operated 9 to 12 hours a night on Monday through Wednesday of each week.

RESULTS. The results deal only with the two most common species collected, *C. tarsalis* and *A. freeborni*; other species constituted less than five percent of the total mosquitoes counted or collected. These species were, in decreasing order of abundance: *Culex peus* Speiser (= *stigmatosoma*), *Culex pipiens* Linnaeus, *Aedes melanimon* Dyar, *Culiseta inornata* (Williston), *Anopheles franciscanus* Mc-

fewer than 50 in a box. There was little difference between the counts of *A. freeborni* and the proportional error was about the same as with *C. tarsalis*. Although not shown in Table 1, the inspector was prone to underestimate the number of male *C. tarsalis*. This phenomenon did not occur with visual estimates of *A. freeborni*. Also, collections from boxes during the latter part of August and through September showed that males of *C. tarsalis* gradually outnumbered the females. The sex ratio of *A. freeborni* remained the same during the entire study period.

The difference in population indices between *C. tarsalis* and *A. freeborni* determined from visual estimates is shown in Table 2. These data show that the nine stations in 1956 demonstrated similar population trends over the period of study.

TABLE 2.—Visual mean weekly counts of *C. tarsalis* and *A. freeborni* (both sexes) in Red Boxes, Sacramento Valley, California, 1956

	Mean number mosquitoes per inspection by week												
Station	July					August				September			
	<i>C. tarsalis</i>												
A	30	44	54	52	57	106	123	88	43	29	36	21	21
B	14	20	31	18	23	41	26	23	15	8	10	11	9
C	23	46	46	43	31	44	23	NI	41	33	28	20	13
D	78	56	356	62	334	407	252	538	158	277	25	150	76
E	16	28	89	104	107	117	64	NI	44	77	32	18	7
F	76	53	323	377	218	167	77	71	49	60	38	26	26
G	52	92	114	101	154	301	216	148	89	64	57	18	14
H	49	114	192	167	179	249	149	111	91	96	44	29	25
I	49	43	99	144	257	327	125	215	41	129	41	66	30
	<i>A. freeborni</i>												
	a	0	a	1	1	6	3	3	1	2	5	44	4
A	1	2	1	1	4	3	5	8	4	8	48	64	29
B	2	4	1	1	3	4	4	NI	16	24	31	63	49
C	8	7	12	3	17	25	21	28	32	40	32	99	78
D	1	3	1	4	3	1	3	NI	11	34	68	73	74
E	a	1	1	2	4	3	7	5	6	2	20	35	50
F	2	4	2	5	4	13	14	12	3	19	50	45	24
G	2	8	6	9	18	16	8	5	2	4	5	10	7
H	2	2	3	2	13	16	13	11	18	38	23	53	16

NI No inspection.

a Less than one.

Source: State of California, Department of Public Health, Bureau of Vector Control Records.

Maximum counts of *A. freeborni* occurred at approximately the same time in boxes placed throughout the study area. With *C. tarsalis*, however, there was greater variability in the time that maximum counts occurred in the same boxes. The degree of agreement among the various boxes was tested by Kendall's (1955) coefficient of concordance which varies from zero to plus one. The coefficients found, 0.726 for *C. tarsalis* and 0.652 for *A. freeborni*, are significant at a probability of .001 and indicate general agreement among the boxes. Similar population trends were obtained from the data on five stations in 1955 but are not included for the sake of brevity. In both years the highest density of *C. tarsalis* generally was in the first part of August, while that for *A. freeborni* was more sharply defined and occurred during the latter part of September.

At one station two additional boxes were inspected in 1956 to check the precision of the first box. The three boxes were placed

on the north side of a home and the box openings faced west. The visual estimates for these three boxes are shown in Table 3. In general, the closeness of the three counts for each species illustrates the reliability of red boxes as sampling devices. On only a few days did the count from one box differ widely from those of the other two boxes. Similarly, for any individual box the daily counts were fairly uniform throughout the week. Similar results were observed with extra boxes placed at each of two other stations.

A comparison of light trap and box counts is shown in Figure 1. For *C. tarsalis*, there were greater fluctuations in light trap collections than in numbers of mosquitoes resting in boxes. Population levels of both species throughout the two years were, however, generally similar regardless of the type of measuring device used. The mean weekly counts of *C. tarsalis* in light traps and in red boxes

TABLE 3.—Daily visual counts of *C. tarsalis* and *A. freeborni* (both sexes) from three red boxes at one location, Sacramento Valley, California, 1956

<i>C. tarsalis</i>					<i>A. freeborni</i>				
		Station					Station		
Date		A-1	A-2	A-3	Date		A-1	A-2	A-3
July	30	42	53	39	September	3	2	2	1
	31	42	40	73		4	3	1	1
August	1	91	58	54		5	1	1	2
	2	71	86	49		6	2	2	2
	3	41	51	32					
Weekly Mean		57	58	49	Weekly Mean		2	2	2
	6	138	172	89		10	9	11	2
	7	90	96	85		11	3	13	6
	8	113	128	163		12	4	13	5
	9	112	116	160		13	5	14	11
	10	78	105	74					
Weekly Mean		106	123	114	Weekly Mean		5	13	6
	13	119	157	143		17	7	12	8
	14	89	102	46		18	76	5	15
	15	135	152	109		19	61	16	4
	16	139	188	141		20	26	41	19
	17	134	149	133		21	6	10	3
Weekly Mean		123	150	114	Weekly Mean		44	17	10
	20	103	97	87		24	1	7	7
	21	84	59	75		25	3	7	3
	24	77	144	76		26	8	17	6
Weekly Mean		88	100	79		27	3	19	4
	27	30	119	38		28	6	12	4
	28	48	43	71	Weekly Mean		4	10	5
	29	60	78	43					
	30	41	41	43					
	31	38	62	53					
Weekly Mean		43	68	49					

Source: State of California, Department of Public Health, Bureau of Vector Control Records.

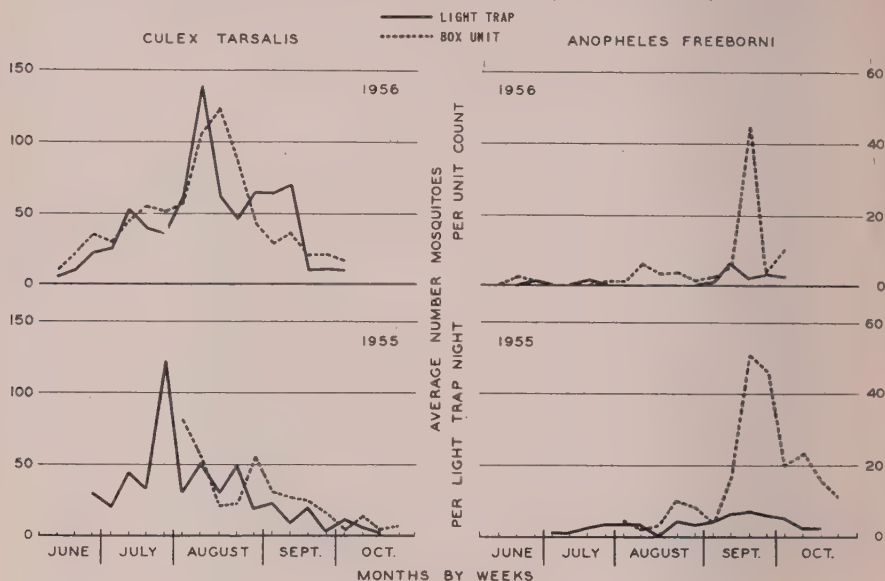
were approximately equal but in general many more *A. freeborni* were counted in red boxes than were collected by light traps. Variations in population trends of the two species were apparent regardless of the type of measuring device used.

DISCUSSION. Fluctuations in *A. freeborni* populations determined from red box counts showed a high degree of correlation among all stations. Light trap collections, although of lesser magnitude, were in like manner consistent. The fact that higher counts were made from boxes than from

light trap collections parallels similar findings for *A. quadrimaculatus* reported by Bradley (1943). Although both devices are useful, the box is especially valuable in areas where operation of a light trap is not possible. Also, the box is a more sensitive device than the light trap in terms of *A. freeborni* response.

The relative numbers of *C. tarsalis* and *A. freeborni* varied considerably from one box to another during both years. The greatest variation occurred during the periods of greatest *C. tarsalis* density.

MOSQUITO POPULATION TRENDS
AS DETERMINED FROM LIGHT TRAP COLLECTIONS¹
AND ARTIFICIAL RESTING UNIT COUNTS¹, CALIFORNIA, 1955-1956



¹ From three consecutive days each week

FIG. 1

There was less variation in the periods of maximum density on the basis of box counts in 1956 when they were inspected more frequently.

The larger fluctuations in density of *C. tarsalis* populations as compared with those of *A. freeborni* are not surprising since larvae of the latter species are, in this area, found predominantly in rice fields, a relatively stable habitat. The larvae of *C. tarsalis* are found not only in rice fields but in a wide variety of other types of water accumulations, many of which are of short duration.

The seasonal trend in adult density of each species found in this study agrees with the results of studies of larval populations made in the same general area by Markos and Sherman (1957). Their data showed that the greatest density of *C. tarsalis* larvae occurred during the end of June while maximum numbers of *A. free-*

borni larvae were found from the end of August through the first part of September.

The error in distinguishing the sexes of *C. tarsalis* in visual counts was due to the less conspicuous sexual dimorphism of this species and also to the large numbers found in the boxes. The finding of more males than females of *C. tarsalis* in red boxes during autumn months was also observed by Dr. R. E. Bellamy (personal communication) in the Southern Central Valley. Similar results were evident from light trap collections in the present study and those by Hayes *et al.* (1958).

The variations in numbers of mosquitoes in boxes from one day to the next could not be attributed to meteorological conditions or time of day at which the counts were made. It may be necessary to make daily inspections each week to minimize this variation, especially when sampling in an area under mosquito control. Similarly,

it is desirable to place several boxes at one location before selecting one unit as a permanent sampling site. Although the boxes located in the present heterogeneous study area showed pronounced variations in weekly *C. tarsalis* counts, Dr. R. E. Bellamy (personal communication) reported similar results with this species and with *Culex quinquefasciatus* Say found in boxes placed in a homogeneous environment. In his study the boxes were placed at the west base of trees randomly selected in the center of a large olive grove.

Some of the merits of red boxes for studying *C. tarsalis* have already been cited by Hayes *et al.* (1958). Of most importance is their low cost and ease of use. As with other sampling devices, however, the location of the box is extremely important. In general, the present authors found that boxes were satisfactory when located in permanent shade and the box opening placed leeward of prevailing winds. All boxes should be inspected on the same day and visual estimates can be used in areas where there are only a few, easily identifiable species. Representative collections should be made at frequent intervals to confirm identifications and estimates of the number present. This is particularly important when the field work is done by individuals with limited experience. Studies in other regions of the Central Valley of California have shown the boxes to be useful also for studying *C. peus* and *C. pipiens*.

SUMMARY. A red, cubical, wooden box of one cubic foot capacity was successfully used as an artificial resting unit to measure seasonal fluctuations in *A. freeborni* and *C. tarsalis* populations in California during the summer months of 1955 and 1956. A similarity in population trends in all boxes was observed throughout the season with *A. freeborni*, and somewhat less consistently with *C. tarsalis*. In general, fluctuations in population levels of each species as suggested by box counts were consistent with those indicated by light traps. Approximately equal numbers of *C. tarsalis* were taken from the light trap and box, whereas larger numbers of *A. freeborni*

were usually taken from the box than from the light trap.

The reliability of the boxes as measuring devices was further substantiated by placing more than one box at a location.

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References Cited

- BRADLEY, G. H. 1943. Determination of densities of populations of *Anopheles quadrimaculatus* on the wing. Proc. 30th Ann. Meetings N. J. Mosquito Exterm. Assoc., pp. 22-27.
- GOODWIN, M. H., JR. 1942. Studies on artificial resting places of *Anopheles quadrimaculatus* Say. Jour. Nat'l Malaria Soc. 1:93-99.
- HAYES, R. O., BELLAMY, R. E., REEVES, W. C., and WILLIS, M. J. 1958. Comparison of four sampling methods for measurement of *Culex tarsalis* adult populations. Mosquito News 18:218-227.
- JAMES, S. P. 1914. Summary of a year's mosquito work in Colombo. Ind. Jour. Med. Res. 2:227-267.
- KENDALL, M. G. 1955. Rank correlation methods. Hafner Publishing Co., New York, pp. 196.
- LOOMIS, E. C., and AARONS, T. 1953. Evaluation of mosquito measurement methods in California, 1953. Proc. and Papers of the 22nd Ann. Confr. Calif. Mosquito Control Assoc., pp. 57-61.
- LOOMIS, E. C. and GREEN, D. H. 1959. Ecological observations on *Culex tarsalis* Coquillett and other mosquitoes in the delta region of the Central Valley of California, 1953-1956 (Diptera: Culicidae). Ann. Ent. Soc. Amer. 52:524-533.
- MARKOS, B. G., and SHERMAN, E. J. 1957. Additional studies on the distribution of mosquito larvae and pupae within a rice field check. Mosquito News 17:40-43.
- ROSS, R. 1910. The prevention of malaria. E. P. Dutton and Co., New York, pp. 669.
- RUSSELL, P. E. and SANTIAGO, D. 1934. An earthlined trap for anopheline mosquitoes. Proc. Ent. Soc. Wash. 36:1-21.
- SCHOOF, H. F. 1944. Adult observation stations to determine effectiveness of the control of *Anopheles quadrimaculatus*. Jour. Econ. Ent. 37:770-779.
- SMITH, G. E. 1942. The diurnal resting place of *Anopheles quadrimaculatus*. Amer. Jour. Trop. Med. 22:257-269.
- SNOW, W. E. 1949. Studies of portable resting stations for *Anopheles quadrimaculatus* in the Tennessee Valley. Jour. Nat'l. Malaria Soc. 8:336-343.

OPERATIONAL EXPERIENCES WITH PARIS GREEN PELLETS IN MOSQUITO CONTROL

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INTRODUCTION. Mosquito control workers have long wished for a cheap, lightweight, effective larvicial material which could be applied on a routine basis against mosquito larvae without danger of their developing resistance and which would not be harmful to people, domestic animals, fish, or wildlife. The recent development of paris green (copper acetoarsenite) vermiculite pellets by the Entomological Research Center of the Florida State Board of Health (Rogers and Rathburn, 1958a) promised to provide a material having many of these desirable qualities. One year's successful experience in routine ground application of paris green pellets has been acquired by the Chatham County Mosquito Control Commission. Their results fully justify the belief that a new, valuable, inorganic chemical tool is available to mosquito control workers.

The use of pellets (granulated carriers) in the control of mosquito larvae offers several advantages, outstanding of which is their great superiority over sprays and dusts in penetrating vegetative cover. In addition, pellets are less affected by thermal air currents and changing wind conditions than sprays and dusts; thus they may be more evenly distributed in larval breeding places. Pellets may be dispensed by airplane during any daylight hour when normally good weather conditions prevail, whereas sprays and dusts usually may be dispensed only during early morning and late evening hours. Finally, it is believed that there are generally fewer toxicity hazards associated with pellets than with sprays or dusts.

In a comparison of pellets with sprays and dusts, however, it must be noted that the secondary effect on adult mosquitoes often achieved with the latter formulations is seldom secured with pellets.

Dr. Griffiths (1927) of the U. S. Public Health Service made studies of mosquito problems in salt marshes along the Atlantic Seaboard and Gulf of Mexico during the years 1926 through 1929. During these studies, he found that paris green mixed with wet sand was a very effective larvicide for *Aedes sollicitans*, *A. taeniorhynchus*, *A. aegypti*, *Culex quinquefasciatus*, and *C. salinarius*. The formulation used consisted of one part of paris green to 99 parts of wet sand by volume. It was applied at the rate of one pound of toxicant per acre. The paris green apparently became coated on the sand during the mixing process. On application by hand to breeding plots, some of the paris green was carried to the bottom by the sand and some remained floating on the water surface.

Paris green mixed with pyrophyllite and other diluents was used extensively for more than 25 years as a larvicide for anopheline control operations. It was usually applied by hand-operated blowers and small power blowers at the rate of one pound of toxicant and 10 pounds of mix per acre. In 1945 the approximate cost of hand application was as follows: (T.V.A. and P.H.S., 1947)

15% paris green, 10 pounds mix/acre:	29¢ per acre
Labor @ 60¢/hour:	48¢ per acre
	77¢ total/acre

No indication of resistance ever developed. Toxicity problems, such as skin rash or effect on fish, wildlife, or domestic animals, were few. Although no indication of resistance developed, resistance to sodium

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arsenite has been reported in cattle ticks when this compound was applied in dips for from 12 years to several decades (Brown, 1958). This experience raises the possibility that mosquito resistance to paris green might develop.

Two general methods were used to check pellet application rates and distribution patterns in the operations described in this paper. One method involved the use of 3" x 12" glass slides coated with car grease (Stains, 1958). The slides were placed on wood floats located on or near the water line. Falling pellets were trapped and held on the car grease. The number of pellets per unit area was determined later using a laboratory bacteria colony counter. The dosage of four pounds of No. 3 vermiculite-paris green pellets per acre represents about 4.2 pellets per square inch or about 0.65 pellet per square centimeter. The other method of dosage measurement used was to catch pellets in 20-inch square wooden pans with 2" high sides. The pellets caught in each pan were run through a small hole in one corner into a stoppered glass vial. Later, the contents of each vial were weighed on an analytical balance.

OPERATIONAL EXPERIENCE WITH PARIS GREEN PELLETS. One year's ground application experience with 15 percent paris green on No. 3 vermiculite has been acquired by the Chatham County Mosquito Control Commission. Field tests indicated that the recommended application rate of four pounds of 15 percent pellet mix per acre (0.6 pound of toxicant per acre) is ample for 100 percent larval kills. Excellent larval kills of *Aedes taeniorhynchus*, *A. sollicitans*, *Psorophora confinnis*, and *Culex quinquefasciatus* have been obtained. Most of the experience acquired has been on the control of salt-marsh mosquitoes, as they are the most important mosquitoes from the standpoint of biting annoyance in Chatham County. The vegetation penetration of these pellets in the many different types of mosquito habitats found in the Savannah area has been remarkable and excellent. Application crews consistently obtained complete

kills in treated breeding places. There was only one incomplete kill during the summer; it occurred when larvae were present in a large expanse (about one acre) of vegetation-free water and a high wind was blowing. The crew re-treated this area successfully on a day when there was less wind. In late fall, a drought occurred resulting in prodigious production of *C. quinquefasciatus* in open drainage ditches heavily polluted with sewage and containing some aquatic vegetation and floating organic material. Excellent kills on these larvae were obtained with the paris green pellets applied by hand-casting from a small boat.

The use of paris green pellet larvicides greatly reduced the expected adult *Culex* and salt-marsh mosquito annoyance in portions of the county. Airplane treatment of large breeding sources inaccessible to ground application crews will be required to obtain a more adequate control of salt-marsh mosquitoes on a county-wide basis.

No. 3 vermiculite has been used for hand application in preference to No. 4 vermiculite because No. 3 is larger and heavier and fewer pellets land on the operator. In addition, No. 3 gives better distribution patterns. No. 3 displays a tendency to spread in all directions after landing in the water whereas No. 4 is more apt to spread only in a downwind direction. These factors, in ground application, outweigh the advantages of more pellets per unit volume obtained with No. 4.

Paris green pellets float for several hours on the water surface after application, thus making it easy to check applications after they are made. It appears that a floating pellet is necessary for this technique. The paris green particles come off the pellet rapidly and most drift slowly down through the water. Some of the particles remain floating on the water surface. Particles of paris green in the water are swallowed by mosquito larvae and act as a stomach poison. Particles are drawn into the esophagus by the current created by the rapidly moving mouth brushes. Paris green pellets must be applied during the 2nd, 3rd, or 4th larval instars since there is little, if any, pre-flood

or residual effect. Applications on larvae broods in the 1st stage were not effective. There is no toxic effect on pupae.

One advantage of pellets is that every control operator can carry a supply and immediately treat breeding sources as great as one acre in size. Pellets weigh only about 16 pounds per cubic foot and only four pounds are required to treat one acre. One-man, hand application crews are possible, economical, and appropriate in many situations. In Chatham County's larvicidal work, it was found desirable and efficient at times to use two-man crews, each crew equipped with a vehicle. Usually pellets were carried in a pail in one hand, leaving the other arm free for hand casting (Figure 1). Employees of the

water were too uneven, and too much of the material was thrown on the operator.

Later, hand crank rotary dusters with a three-foot long discharge tube were tried in the field. This type of dispersal equipment produced good pellet distribution patterns in the water, but proved too slow in comparison with hand casting. Other difficulties noted were clogging of the equipment and separation of paris green particles from the pellets in the duster impellers.

Thus, the hand casting method, using a pail, proved to be the best technique of application and was most used. In a time-motion test in shallow water, it was found that one man could treat one acre in 30 minutes using this technique. There is a need for light hand-dispersal equipment which will increase swath width and rate of application and propel the pellets away from the operator.

As in all hand-larviciding operations, there is a strong tendency to use more material than necessary. An early check of the hand-casting technique showed that the field application rate was about 57 pounds of paris green pellets per acre. In order to train operators in the correct rate of application, a one-quart capacity hand shaker applicator was devised. Such a shaker can be made from mailing tubes commonly used by entomologists. Eighteen $\frac{1}{4}$ -inch holes were drilled in the metal cap. An area on the ground measuring 75 x 75 feet was marked off. Each crew member then regulated the application so that one quart evenly treated the 75 x 75 foot area. This gave good reference experience to the operators in the amount of pellets required and greatly reduced over-treatment. The shaker was very useful for treating small breeding places during regular operations. In a time-motion test in shallow water, one man could treat a 75 x 75 foot area in 3 minutes and one acre in 30 minutes using the hand shaker.

It was noted that field men tended to increase the dosage when treating heavy concentrations of larvae. One check in a heavily breeding and heavily vegetated area 80 by 2,000 feet showed an application rate of 24.5 pounds of mix per acre.



FIG. 1.—Hand-casting 15% paris green on #3 vermiculite pellets in Savannah, Ga., *Distichlis* salt-marsh.

commission were most pleased with the ease and convenience of applying pellets and with their effectiveness in killing larvae. They considered fuel oil much more difficult to apply.

At the beginning of control operations, rotary grass seed distributors operated by a hand crank were used for dispensing paris green pellets. They were soon discarded because distribution patterns in the

A study of all the field checks indicated the actual average field application rate was about 10 pounds of mix per acre.

A total of 6,990 pounds of paris green pellet mix was used in Chatham County in 1958. Assuming 10 pounds per acre, a total of 700 acres were treated using 915 man hours for inspection and treatment. Cost figures per acre were:

Materials	\$1.20 per acre
Labor, formulation	.25 per acre
Inspection and treatment	1.60 per acre
Vehicle	.15 per acre

	\$3.20 per acre

The total cost per acre could be reduced to about \$2.50 per acre by taking measures to achieve the recommended dosage of 0.6 pound of actual paris green per acre. One such measure would be to reduce the paris green formulation strength to 7½ or 10 percent.

Component costs of the pellets were: paris green \$.43 per pound, Triton N-101³ \$.27 per pound, and No. 3 vermiculite \$1.10 per 4 cubic foot bag (weight about 32 pounds).

The batch formula used in Chatham County in 1958 was as follows:

1. No. 3 vermiculite = 2 four cu. ft. bags.
2. 90% paris green = 20 pounds.
3. Sticker = 5 gallons.

The sticker contained 10 percent Triton N-101, 30 percent water, and 60 percent 40W motor oil by volume and was mixed in a 55-gallon drum. It is important to follow the sticker formula closely. The Triton should be added to warm water and mixed thoroughly before slowly adding the motor oil. A motor driven pump was used to provide agitation by recirculation and to power the spray application of the sticker onto the pellets.

The vermiculite should be free of fine dust particles when purchased. If not, dust should be removed by using a 30-mesh screen. Some differences have been noted in the size and shape of vermiculite processed in different plants. The follow-

ing mesh analysis was made on paris green pellets made up with No. 3 vermiculite obtained in 1959 from a Savannah, Georgia source:

Held on screen number	Percent of total by weight
10	4.4
16	36.5
20	32.8
25	14.2
30	4.2
Pan (less than 30)	7.9

The 1959 vermiculite product was somewhat superior to that obtained in 1958 because, as a result of a visit to the plant, more of the finer sized particles were eliminated by the manufacturer through rearrangement of the shaker screens.

In formulating the larvicide, the vermiculite is placed in a concrete mixer and rotation started. The sticker is then applied through an 8006 spray nozzle. Finally, the paris green is added slowly. The mix is then spread in a thin layer 2-3" thick for 24-48 hours of air drying.

Mixing of paris green pellets is a good wintertime or rainy day job for mosquito control organizations.

The only difficulty experienced in pellet application during the summer of 1958 was several light and one severe case of rash. The mild cases involved skin folds: neck, eyelids, scrotum, inside portion of elbows, and armpits. There is an apparent association between the rash and sweating and/or rubbing. The worker with the severe rash was very careless in handling the pellets and may have had a special sensitivity to the material. An injection of sodium thiosulfate by his physician relieved the symptoms overnight. It was concluded that this severe rash was probably caused by the paris green in the formulation since similar and highly characteristic poisoning has occurred in other workers (Von Oettingen, 1958). The light cases of rash may have been caused by the paris green or possibly by the vermiculite, which is an exploded hydrated variety of biotite, one of the groups of materials found in mica. Most of the difficulty was associated with the use of hand operated rotary grass seed distributors, which threw a considerable

³ Use of trade names in this paper is for identification purposes only and does not constitute endorsement by the Public Health Service.

amount of the pellets on the operators. Skin rashes resulting from the hand casting method have been less frequent. Pellets should be applied in a downwind direction as much as possible. Frequent washing and the use of drying powders are helpful in preventing rash. Operators may protect their casting hand with a loose fitting rubber chemical glove.

No special precautions were taken with regard to domestic animals, fish, or wildlife. Paris green does not persist in water (Brown, 1951). The only evidence of possible harm was a few dead tadpoles which were observed one day only. Repeated applications have been made in pastures containing feeding livestock with no known deleterious effect; however, it seems prudent to exercise caution in this type of application. The observation of depression and skin lesions in livestock would call for studies to determine whether arsenic poisoning was responsible (Brown, 1951).

OPERATIONAL TESTS WITH POWER DUSTERS AND AIRPLANES. Limited tests, with greased glass slides, show that a power dust machine such as the Buffalo Turbine can successfully apply No. 3 paris green pellets to a swath as wide as 100 feet. Only the middle hopper in the Buffalo Turbine was used when dispensing pellets. DDT on No. 4 vermiculite pellets is being successfully applied in Illinois mosquito control districts (Buchanan, 1958) by Buffalo Turbines and helicopter, both as a pre-flood application for the control of *Aedes vexans* as well as postflood treatment for the control of many mosquito species.

Several test flights were made in Savannah this winter using No. 3 vermiculite (15 percent) paris green pellets dispensed by fixed wing aircraft. Two test flights were made in late 1958 with the Public Health Service AT-6 single engine airplane which was used in successful parathion-attapulgitte pellet larviciding in 1956 in Florida (Fehn, Taylor, and Rogers). The old formulation containing water was used. It was noted that the paris green pellets tended to compress in the hopper interfering with free flowing. Also, it was noted that vermiculite pellets are more affected by wind

than a heavier pellet-like attapulgitte. As a result, the applications were uneven and under-dosed. Comparisons between greased slides placed above and below 18-inch-high salt grass (*Distichlis spicata*), 3-foot-high dense upright weeds, and 8-foot-high reed grass indicated that these pellets possess excellent vegetation infiltration characteristics. Pellets caught in wooden pans remained fully effective on 4th stage laboratory *A. taeniorhynchus* larvae in shallow pans, showing that loss of paris green particles during aerial dispersal was not significant. These tests indicated the necessity of modifying the dispensing equipment or improving the formulation.

In March 1959, six test flights were made with Cub airplanes using the new waterless No. 3 vermiculite formulation described below. A 150 h.p. Super Cub with the standard factory-installed dust dispensing equipment was used in three tests. A 115 h.p. Cub with specially designed light, pellet-dispensing equipment (Scott Air Service, Savannah, Georgia) was used in the other three tests. Pellets flowed evenly from both airplanes and were caught on pans and greased slides in open fields. The results indicated that a satisfactory distribution with a swath width of 50 feet can be obtained from both airplanes at a 75' altitude. Dispersions from a 50' altitude were narrowed to a 25-foot swath. Dispersions from a 100' altitude produced erratic results. Further operational tests are needed on aircraft application.

CHATHAM COUNTY OPERATIONAL PLANS FOR 1959. The newest formulation being tested in Florida (Rogers and Rathburn, 1958b) is being used because it contains no water and does not require drying after mixing:

Paris green—17 pounds
Emulsifier Triton N-101 (10%) plus Standard Oil Co. spray oil (90%) No. 345 (\$0.30 per gallon)—4 gallons (30 pounds)
Vermiculite—53 pounds

No. 3 vermiculite is being used for ground applications. Operational tests will be made to determine whether No.

3 or No. 4 vermiculite is superior for aerial application.

Results of ground application in 1958 indicate the general advisability of decreasing the strength of formulation and increasing the rate of pellet application. Accordingly, experiments in these directions will be made using $7\frac{1}{2}$ and 10 percent pellets.

The Chatham County Mosquito Control Commission purchased a 150 h.p. Super Cub airplane in 1959 for application of paris green pellets. Such a light airplane will permit effective and economical treatment of salt-marsh areas as small as one acre. Assuming an 18 cubic foot hopper and a 10-pound per acre application of 15 percent paris green pellets, 28 acres could be treated per mission. Assuming a 50-foot swath width and 85 m.p.h. speed, the plane could treat 8.6 acres per minute of pellet dispersal time. Assuming one pilot and an average of 14 missions per day, one plane could treat 392 acres per day. Under the conditions described above, the cost per acre for paris green pellet application by airplane would be: \$1.20 for materials, 25 cents for formulation labor, 12 cents for aircraft operations (gas and the pilot) and 3 cents for loading (one laborer), or a total of about \$1.60 per acre. The airplane cost figure does not include other airplane costs such as depreciation, maintenance, insurance, etc. Thus aerial application will be much faster and cheaper than ground application as well as provide control in breeding places inaccessible to ground crews.

SUMMARY. Pellets are greatly superior to sprays and dusts as mosquito larvicides in penetrating vegetation, in effectiveness under adverse wind and thermal conditions, and in reduced toxicity hazards.

One year's successful experience in the ground application of 15 percent paris green on No. 3 vermiculite at the average rate of 1.5 pounds of toxicant per acre

on *Aedes*, *Psorophora*, and *Culex* mosquito larvae has been acquired by a county mosquito control district. The excellent results obtained indicate that an important light-weight larvicide has been made available. It combines the vegetation-penetrating abilities of pellets with an inorganic insecticide that can be safely, effectively, and economically used routinely on a large scale. There appears to be little possibility of resistance occurring until at least several years of extensive use. Meanwhile, the effectiveness of chlorinated hydrocarbon, and organic phosphorus insecticides will be preserved for use as adulticides.

References Cited

- BROWN, A. W. A. 1951. Insect control by chemicals. John Wiley & Sons, Inc., New York City, 817 p.
- BROWN, A. W. A. 1958. Insecticide resistance in arthropods. World Health Organization Monograph Series No. 38, Geneva, 240 p.
- BUCHANAN, W. J. 1958. Personal communication (Manager of South Cook County Mosquito Abatement District, Harvey, Illinois).
- FEHN, C. F., TAYLOR, JOHN W., and ROGERS, ANDREW, J. 1956. Operational experiences with parathion pellets in mosquito control. Mimeographed reports.
- GRIFFITHS, T. H. D. 1927. Moist sand method of applying paris green for destruction of sub-surface feeding mosquito larvae. U. S. Pub. Hlth. Rpts. 42:2701-2705.
- ROGERS, ANDREW J. and RATHBURN, CARLISLE B., JR. 1958a. Tests with a new granular paris green formulation against *Aedes*, *Anopheles*, and *Psorophora* larvae. Mosq. News 18:89-93.
- ROGERS, ANDREW J. and RATHBURN, CARLISLE B., JR. 1958b. Information on granular paris green larvicide. Report of the 29th annual meeting, Florida Anti-Mosquito Association, pp. 40-43.
- STAINS, G. S. 1958. Personal communication, Naval Medical Field Research Laboratory, Marine Corps Base, Camp Lejeune, North Carolina.
- TENNESSEE VALLEY AUTHORITY and U. S. PUBLIC HEALTH SERVICE. 1947. Malaria control on impounded water. G.P.O. Washington 25, D. C., 422 p.
- VON OETTINGEN, W. F. Poisoning. 1958. A guide to clinical diagnosis and treatment. Second edition, W. B. Saunders Co., New York, 627 p.

ARTICLES

OVERWINTERING LARVAL POPULATIONS OF *CULEX*
ERYTHROTHORAX IN NEVADA

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In the last few years *Culex erythrothorax* Dyar has been found in several western States and Mexico. Carpenter and LaCasse (1955) reported it from Utah, Idaho, California, and Mexico; Menzies *et al.* (1955) from Texas, and Richards *et al.* (1956) from Arizona and three counties in Nevada. In Utah, Rees (1944) noted that females bit viciously and that larvae sometimes became numerous late in the fall. Small numbers of overwintering females were observed by Loomis and Green (1955) in natural resting places in central California.

The genera *Culiseta*, *Orthopodomyia*, *Wyeomyia*, and *Mansonia* are known to contain some species that overwinter as larvae in the United States. *C. erythrothorax* and other species of *Culex* have been observed overwintering only as adults except in the South, where *salinarius* Coq., *quinquefasciatus* Say, and *nigripalpus* Theob. breed throughout the year.

A large population of fourth instar *erythrothorax* was noted near Reno in Washoe County on October 8, 1958, in a sunlit, flooded area where the common tule (*Scirpus acutus* Muhl.) and common three-square (*Scirpus americanus* Pers.) were the principal plants. Repeated checking during the next few weeks indicated that the population was not pupating as expected. The studies initiated are reported herein.

FIELD OBSERVATIONS. Data from the almost weekly dipping of the Washoe County area from October through the

first week in February and from two areas in Lyon and Churchill Counties from January to early May are presented in Table 1. The data show that in the Washoe area a few pupae were dipped in late October and none after November 3. A few adults were observed and several bites received on November 3. The presence of biting adults and the absence of egg rafts so late in the season probably indicate that a small segment of the population overwintered as adult females. This population was destroyed when the area was drained in early February at the end of the duck-hunting season. Prior to this, two separate populations were located in Lyon County adjacent to Fernley and near Fallon in Churchill County. Larvae of *erythrothorax* were present in sunlit tule ponds with vegetation similar to the Washoe County area. The pH of the ponds in the three areas ranged from 7 to 8.

The populations consisted of many second, third, and fourth instar larvae, with the last instar dominant in latter March. The first pupae were observed on March 31. About 50 percent of the population were pupae on April 16 and 74 to 92 percent by the latter part of April. Only one larva and no pupae were noted on May 13, but biting adults were prevalent.

Surveys during the winter months in areas that had contained water since early fall indicated widespread numbers of *erythrothorax*, especially in seep ponds between Fernley and Fallon. Associated larvae in October and November were *Culex tarsalis* Coq. and *Culiseta inornata* (Will.), whereas only *inornata* was noted

¹ In cooperation with the Nevada Agricultural Experiment Station.

TABLE 1.—Larvae and pupae of *Culex erythrorhax* collected in three counties in Nevada during 1959

Month	Washoe			Lyon			Churchill		
	Number of dips	Average number per dip		Number of dips	Average number per dip		Number of dips	Average number per dip	
		Larvae	Pupae		Larvae	Pupae		Larvae	Pupae
October 1958	560	7.7	0.01	—	—	—	—	—	—
November	210	10.2	<.01	—	—	—	—	—	—
December	180 ¹	3.9	0	—	—	—	—	—	—
January 1959	140 ¹	4.4	0	130	3.3	0	160	7.9	0
February	55 ²	0.9	0	180	5.3	0	180	11.9	0
March	—	—	—	240	5.6	0.05	240	12.8	0.01
April	—	—	—	240	2.1	1.4	240	3.1	2.2
May	—	—	—	60	0	0	60	0.02	0

¹ Ice often present with dipping difficult.² Observations discontinued on February 5 because of lack of water.TABLE 2.—Temperature (° F.) for three areas in Nevada for October 1958 through April 1959¹

Date and area	Average		Lowest	Number of days 32° F. or below
	Minimum	Maximum		
1958				
October				
Fallon	35.8	75.5	20	9
Fernley	36.4	74.4	22	8
Reno	31.6	73.5	17	15
November				
Fallon	24.6	58.6	5	23
Fernley	25.7	57.0	5	21
Reno	21.3	56.1	1	28
December				
Fallon	20.8	54.4	9	29
Fernley	22.6	52.8	13	29
Reno	21.1	54.2	13	31
1959				
January				
Fallon	22.6	52.7	1	25
Fernley	24.3	50.6	3	27
Reno	22.5	50.5	5	28
February				
Fallon	23.2	51.5	6	25
Fernley	23.4	50.0	10	26
Reno	21.0	46.7	3	26
March				
Fallon	25.5	64.0	15	29
Fernley	28.1	63.2	18	26
April				
Fallon	33.6	73.6	21	14
Fernley	36.1	73.1	21	12

¹ From climatological data of U. S. Weather Bureau.

after November and throughout the winter and early spring. Both *tarsalis* and *Anopheles freeborni* Aitken were companion species after April.

LABORATORY OBSERVATIONS. Samples of larvae were brought in from these three areas and part of each sample was kept in the heated laboratory and the remainder placed in an outside environment. The samples were replenished when necessary owing to accidents and mortality. No pupae or cast skins were noted in the outdoor samples until March 14. Pupae were abundant in early April and the length of the pupal stage in April ranged from 6 to 8 days.

The phenomenon of delayed development of winter-collected larvae of *Culiseta melanura* (Coq.), even when brought indoors, as reported by Smith (1904) and Burbutis and Lake (1956), does not seem to apply to *erythrothorax*. It appears that their overwintering is contingent principally on the temperature, as larvae changed instars, pupated, and emerged as adults when held at room temperature. During the winter a few larvae pupated each day, and the pupation of a sample of fourth instars extended over several weeks. This time was reduced to a week in April. The time in the pupal stage ranged from 2 to 4 days.

GENERAL WEATHER CONDITIONS. The temperatures in the three areas during the period of these observations are given in Table 2. The U. S. Weather Bureau stations were located some distance from the study areas, and the data were taken at the 6-foot rather than ground level. Temperatures as low as 1° F. were

recorded, and ice was present during most nights in November through March. Ice more than an inch thick covered the areas for several successive days, with no apparent adverse effect on the larvae.

CONCLUSION. Even though the continuity of the initial study was unavoidably broken, sufficient data are presented to show the presence of larvae and absence of pupae of *Culex erythrothorax* from early November until late in March. Probably a few adult females overwinter, especially in Washoe County, but the most important overwintering stage is the larva. Since this species was absent from these areas in July, August, and early September, and was not noted in other areas, females may aestivate in Nevada.

Literature Cited

- BURBUTIS, P. P., and LAKE, R. W. 1956. The biology of *Culiseta melanura* (Coq.) in New Jersey. Proc. N. J. Mosquito Extermination Assoc. 43:155-61.
- CARPENTER, S. J., and LACASSE, W. J. 1955. Mosquitoes of North America. 360 pp. Univ. Calif. Press.
- LOOMIS, E. C., and GREEN, D. H. 1955. Resting habits of adult *Culex tarsalis* Coq. in San Joaquin County, California, November 1953 through November 1954. A preliminary report. Proc. 23rd Annual Conference of California Mosquito Control Association, pp. 125-7.
- MENZIES, G. C., EADS, R. B., and HARMSTON, F. C. 1955. The discovery of *Culex erythrothorax* Dyar in Texas. Mosquito News 15(4):235-6.
- REES, D. M. 1943. The mosquitoes of Utah. Bull. Univ. Utah, Biol. Series 33, 99 pp.
- RICHARDS, C. S., NIELSEN, L. T., and REES, D. M. 1956. Mosquito records from the Great Basin and the drainage of the Lower Colorado River. Mosquito News 16(1):10-7.
- SMITH, J. B. 1904. Report N. J. State Agric. Expt. Sta. The mosquitoes occurring within the State, their habits, life history, etc., pp. 319-25.

**Paul Revere had to use a horse, but he got there just the same.
You can do it too—but use a plane or train.**

METHOD FOR THE FIELD DETERMINATION OF SUSCEPTIBILITY LEVELS OF ADULT MOSQUITOES¹

WILLIS MATHIS, H. F. SCHOOF AND R. W. FAY

During the early use of residual insecticides against mosquito vectors, the control of the insects and the reduction of diseases such as malaria were spectacular. More recently, however, mosquito control efforts in many areas have become increasingly difficult because of the development of insecticide-resistant populations. Since unsatisfactory control also can arise from inadequate insecticide applications, defective chemicals, or the action of environmental factors on the residues, it is important to determine the correct cause for the operational failure. The need for a suitable field technique as a means of determining the susceptibility level of the vector population to the toxicant involved soon became obvious. Consequently, in 1956, studies were begun to develop a kit which would contain all essential equipment for conducting tests in any locality, would be compact enough for a person to carry easily, and would be durable under tropical climatic conditions. Efforts were made to incorporate the more important features of existing test methods (Fay *et al.*, 1953; Busvine and Nash, 1953), and so far as possible produce a method having simplicity, sensitivity, accuracy, and reproducibility under field conditions.

MATERIALS AND METHOD. The complete test kit (Figure 1) is contained in a sturdy marine-plywood carrying case (14½" by 22" x 6"). It includes the following items: 2 plastic aspirator tubes; 30 wire-screen-top threaded-base plastic tubes (125 mm. long by 44 mm. diameter) with 10 marked red for use as exposure tubes and 20 unmarked for use as holding tubes; 30 screw-cap metal bases equipped with slid-

ing metal closures; 30 metal spring clips; 16 impregnated papers each of five DDT-Risella oil concentrations, of six dieldrin-Risella oil concentrations and of Risella oil only; and miscellaneous auxiliary items such as untreated papers, rubber bands, cotton, forceps, record forms, graph paper, and instructions. The test papers² (Whatman No. 1 or Schleicher-Schull 2043A 120 mm. x 150 mm.) are commercially impregnated to give residual deposits of 360 mg./100 sq. cm. of 0.25, 0.5, 1.0, 2.0, and 4.0 percent DDT in Risella oil and of 0.05, 0.1, 0.2, 0.4, 0.8, and 1.6 percent dieldrin in Risella oil.

In a typical test sequence, the adults of the desired species are aspirated from natural resting sites and 25 to 30 specimens are placed in a single holding tube (Figure 2, steps 1 and 2). Subsequently, these specimens are transferred to an exposure tube fitted with a treated paper. To do so, the metal bases of a holding and an exposure tube are placed together, the metal slides are opened, and the mosquitoes are gently blown into the exposure tube (Figure 2, steps 3 and 4) which is placed in an upright position. At the end of a 1-hour exposure period, the mosquitoes are returned to a holding tube, lined with an untreated paper, by reversing the transfer procedure described above. Paper is substituted as a cover for the holding tube and a cotton pad soaked in sugar solution is placed on the screened end of the tube (Figure 2, steps 5 and 6). At the end of 24 hours, the specimens incapable of resting on the sides of the tube are counted as dead, and the percentage mortality is calculated.

In the application of the kit for resistance

¹ From the Communicable Disease Center, Bureau of State Services, Public Health Service, U. S. Department of Health, Education, and Welfare, Savannah, Georgia.

² Furnished through the courtesy of the World Health Organization, Geneva, Switzerland.

determinations, an initial baseline of response of a given species of mosquito to various concentrations of DDT or dieldrin is established. Subsequent routine checks then are made periodically to determine any change in the response of the species. The method does not reflect variations in the behavioristic response of the insects, but measures their ability to survive contact with the test residues for a specific time under certain conditions. Since these conditions do not reflect the actual exposure of the insect to field control application, the method should not be used to compare the field effectiveness of different insecticides. Essentially, it is designed to detect physiological resistance levels of sufficient magnitude to hamper control operations.

In determining the base line of susceptibility values, mosquito populations should

be sampled from several locations in the program area and processed as follows for each insecticide:

(a) Run one test (20-25 specimens) with each insecticidal concentration and with a *Risella*-oil control, using a 1-hour exposure period. If these tests provide the desired mortalities—one concentration giving less than 50 percent mortality and one (or preferably two) giving complete mortality—proceed to step (c).

(b) If the initial tests do not provide the desired mortality levels noted in step (a), shorter exposure periods of 15 or 30 minutes, or longer exposure periods of 2, 4, or 8 hours should be tried. If suitable values are then obtained, proceed to step (c). If 8-hour exposures to the highest concentrations fail to produce essentially complete mortality, the species may be assumed to have a level of resistance. How-



FIG. 1.—Resistance kit.

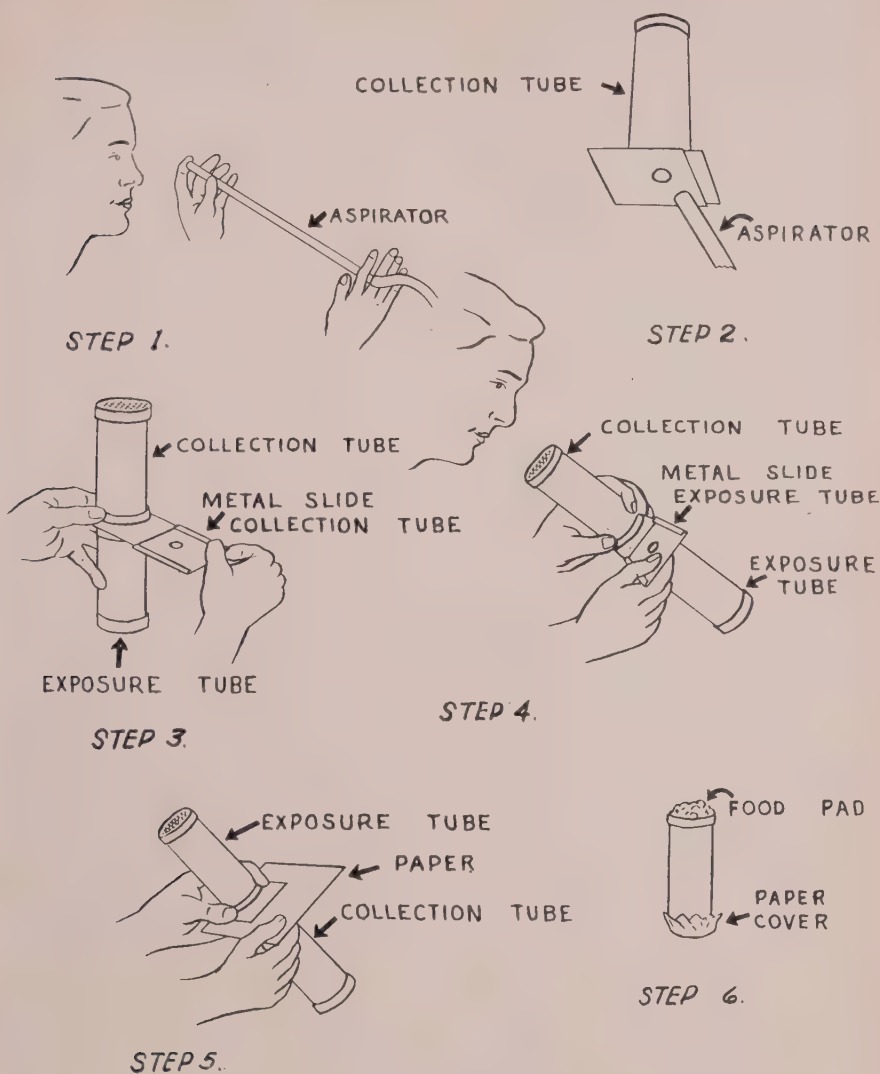


FIG. 2.—Steps in making test.

ever, these results should be verified as in step (c).

(c) Using the concentrations giving the desired mortalities from steps (a) or (b), run four additional replicates of each of these dosages, including a Risella-oil control with each test series. The average

mortalities of the five replicates from step (c) + (a) or (b) are taken as the values for establishment of the base level of susceptibility. The lowest insecticidal concentration which showed complete mortality is chosen for the subsequent routine concentration in step (d). If the average

mortality of the five replicates at the highest concentration is at least 95 percent, this concentration may be used in step (d).

(d) After the establishment of the base level of susceptibility, five replicates at the routine concentration chosen in step (c) are run at suitable intervals to detect any change in the response of the field population. If complete mortality again is obtained, no change in susceptibility is indicated. If survivors occur, they may result from seasonal or environmental changes or may indicate physiological resistance. These possibilities are distinguished in step (e).

(e) Run two replicates at each of the concentrations used in step (c). If the results show (1) approximately the same mortalities for concentrations which gave less than 95 to 100 percent mortality in step (c), and (2) mortalities of less than

100 percent for concentrations which originally gave complete mortality, the change is indicative of physiological resistance in the mosquito population. This should be confirmed by a second series of replicates. If the results show a lower mortality for all test concentrations, the change is indicative of a seasonal or environmental variation in response. These types of response are illustrated in Figure 3.

DISCUSSION. The application of the test procedure to field conditions assumes that at least three test concentrations will be available for obtaining the baseline, one giving less than 50 percent mortality and one (or preferably two) giving complete mortality. However, with populations already resistant, such is not possible, e.g., with a strain of *Aedes aegypti* from Cucuta, Colombia, no mortality was obtained even with the maximum DDT

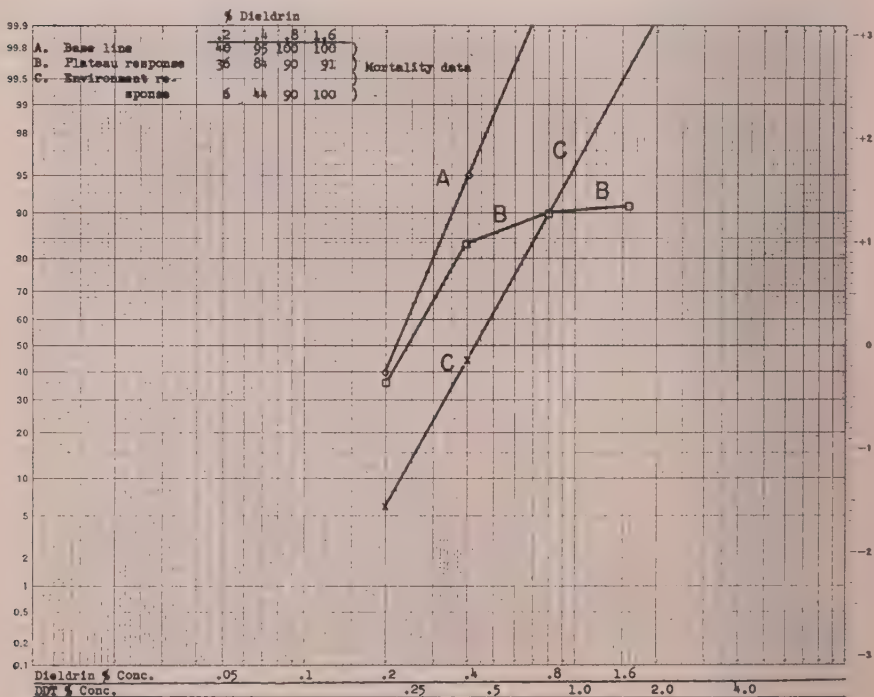


FIG. 3.—Dosage mortality lines.

concentration, thus indicating a high level of resistance to that toxicant. In tests with DDT-Risella oil papers against a local field strain of *Aedes taeniorhynchus*, the highest concentration (4 percent) gave 96, 98, and 99 percent 24-hour mortalities after 1-, 2-, and 4-hour exposures, respectively.

TABLE 1.—Twenty-four-hour mortalities^a (percent) of adult female *Culex quinquefasciatus* with 90- and 150-minute exposures to dieldrin-Risella oil impregnated papers

Conc. dieldrin (percent)	Mortality (percent) with exposure of	
	90-min.	150-min.
0.1	2	0
0.2	2	14
0.4	16	25
0.8	33	53
1.6	45	42
3.2	33	44
4.0	29	61

^a Mortality values represent the means of two replicates each.

Since complete mortality was not quite obtained even with the 4-hour exposure period, the investigator has to accept the possibility of a low proportion of resistant individuals in the population, and proceed on the basis of the survival of occasional individuals, and the use of 95 percent mortality as a recheck value.

The method also assumes that the mortality plotted in probit units on log-dosage graph paper will be essentially a straight line function. This assumption has been true with laboratory strains and with certain field strains. In other field strains, however, such as *Culex quinquefasciatus* (*fatigans*) (Table 1), there was a break in the mortality response to increased dosage which resulted in a plateau-type response. In a field strain of *Aedes taeniorhynchus* from Savannah, 4-hour exposure to 0.2, 0.4, 0.8, and 1.6 percent dieldrin-Risella oil papers gave 12, 33, 39, and 39 percent 24-hour mortalities, respectively. Here the mortality data indicate partially resistant populations, and a straight line response of probit mortality to log dosage no longer occurs.

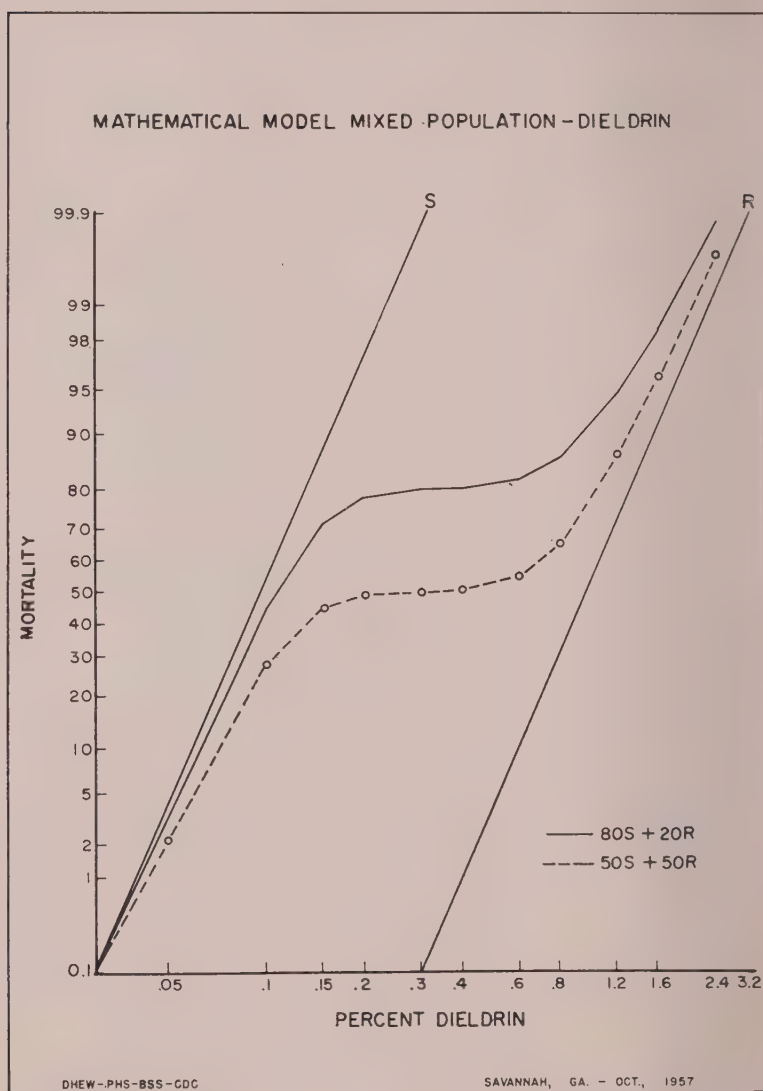
The basic concept of a straight line relationship between probit mortality and log dosage assumes a homogeneous population in which the individuals differ from each other in their response in a continuous fashion. In an essentially completely susceptible strain, or in a highly selected resistant strain, this concept may still apply. All the individuals in laboratory strains are held under essentially equal conditions and tend to become uniform in their response to whatever selective factors are present. In field strains, however, the same selective factors are not exerted on the entire populations, and greater variation prevails. Marked differences were shown to dieldrin-Risella oil papers by a laboratory and a field strain of *Anopheles quadrimaculatus* (Table 2). The field strain is composed of a mixed population of approximately 75 percent susceptible and 25 percent resistant individuals. The susceptible portion of the field strain in this case is more susceptible than the laboratory strain. Between the susceptible and resistant individuals of a mixed pop-

TABLE 2.—Twenty-four-hour mortalities^a (percent) of adult female *A. quadrimaculatus* of an insectary (Savannah) and of a field (Lynah) strain with 90-minute exposures to dieldrin-Risella oil impregnated papers

Conc. dieldrin (percent)	Mortality (percent)	
	Savannah	Lynah
.1	8	44
.2	0	64
.4	20	75
.8	100	78
1.6	100	80
3.2	—	87
4.0	—	94

^a Mortality values represent the means of eight replicates each.

ulation, there apparently is a decided break in the mortality response with an increase of exposure time. As shown in the mathematical model (Figure 4), the susceptible portion of the population may respond in a linear fashion following the line S , whereas the resistant portion of



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FIG. 4.—Mathematical model mixed population-dieldrin.

the population respond along the line R. Mixed populations of 80 percent susceptible and 20 percent resistant, or of 50 percent susceptible and 50 percent resistant, would follow the curved lines shown with a plateau effect occurring at approximately the proportion of the mixed populations. The plateau effect becomes more marked if the differences between susceptible and resistant individuals are greater.

This type of response was demonstrated in the laboratory using a mixture of a susceptible (S) and a dieldrin-resistant (C) strain of *A. quadrimaculatus*. Twenty-five adults removed from mixed populations containing known proportions of each strain were exposed to dieldrin-Risella oil test papers. The resultant values (Figure 5) show a plateau effect at approximately the expected levels with some irregularities which probably arose from the fact that the samples did not contain true proportions of the mixed population, or from the percentage (3-5) of susceptible individuals which existed in the resistant strain.

A field population prior to exposure to chemical measures may show a linear response of probit mortality to log dosage and still contain a small undetected segment of resistant individuals since only a small portion of the total adult population is being sampled. With the institution of control measures the susceptible population may be greatly reduced (particularly apparent if specimens are captured inside treated dwellings). Thus, the ratio of resistant to susceptible individuals in the population is increased and the resistant portion of the population now may be evident and cause the mortalities to fall below 100 percent. This drop in mortality levels indicates a definite resistance potential in the population.

The usefulness of this resistance detection method lies equally on the manner and accuracy followed in conducting the tests, and on the interpretation which is given the results. The method should not be expected to provide a consistent narrow range of mortalities, since even

under controlled conditions the variation in mortalities of laboratory-reared specimens in replicated tests varies as much as 30 to 35 percent. Consequently, the average mortality of 4 to 5 tests is the assessment index to be considered.

Of the components in the kit, the impregnated papers theoretically offer the greatest chance of variability. However, extended studies of these papers indicate that:

(a) Preparation of the test residues by a single commercial source appears to be the best guarantee of uniformity. Papers prepared commercially at three different impregnation dates over a 1-year period gave comparable results.

(b) Under repeated tests with four individual 4 percent DDT papers, a series of fifty-five 60-minute exposures with each paper showed a mean mortality of 88 percent (range 67-100 percent). A series of thirty-three 90-minute exposures with each of four 0.8 percent dieldrin papers showed a mean mortality of 93 percent (range 62-100 percent). The current recommendation is that each paper be used about 20 times.

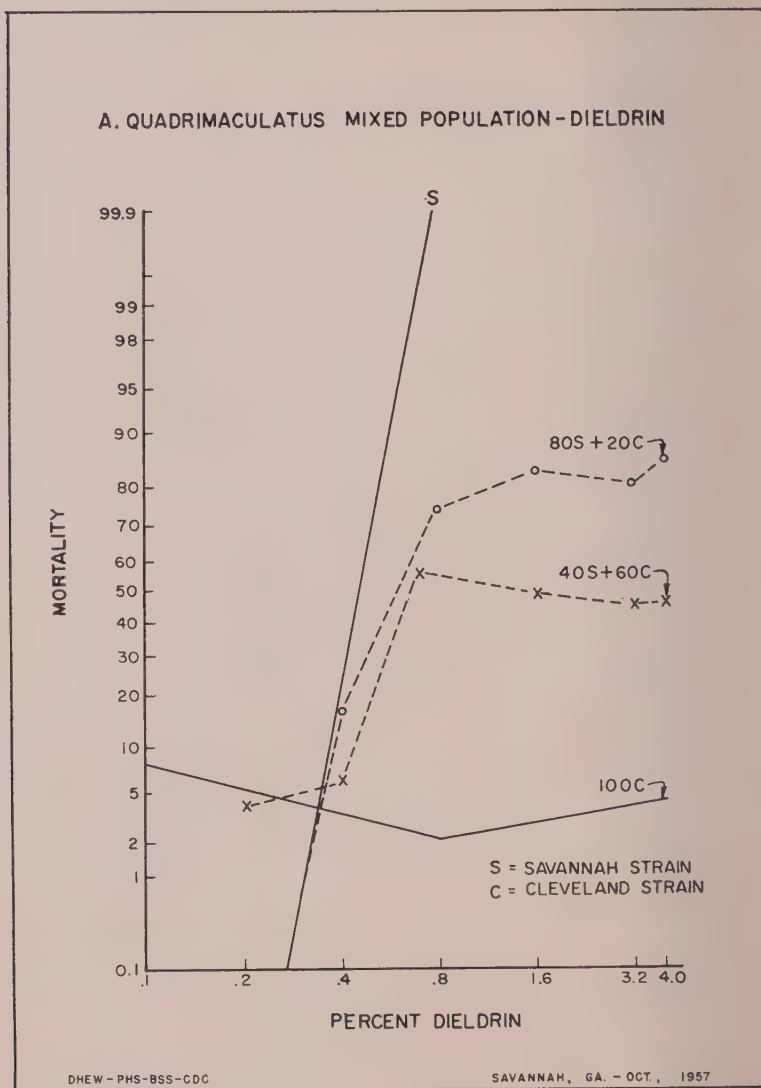
(c) Two papers each of 4 percent DDT-Risella oil and of 0.8 percent dieldrin-Risella oil which were tested weekly over a one-year period maintained their effectiveness. It is recommended that papers may be used for one year from the date of impregnation.

(d) The deposits of both toxicants remained stable under 80° F. storage for at least 1 year, but at 115° F., the DDT-treated papers showed some loss of effectiveness after 2 months of storage.

(e) The Risella-oil base itself does not have any measurable action on test mosquitoes and mortality is a function of the insecticide only.

From these data, it is apparent that preparation, storage, and usage in the time periods and condition specified have little effect upon the reliability of the impregnated papers.

In the interpretation of data, the investigator must rely on the general guide

FIG. 5.—*A. quadrimaculatus* mixed population-dieldrin.

lines previously indicated. Completely susceptible or highly resistant strains are readily differentiated, but those falling between the extremes may sometimes be difficult to assess. The chief criterion for resistance concerns the appearance of a plateau response to an increase in insecticide concentration. Where such evidence appears, its relationship to the failure or success of the program must be interpreted by the field personnel familiar with the control area.

Thus, the kit data establish whether or not a vector population is developing physiologic resistance to the toxicant employed. The influence of such findings must be weighed against other factors (*i.e.*, mosquito indices in dwellings, parasite rates) to obtain an overall evaluation of resistance as to its effect upon the eradication program.

In addition to detecting resistance development in vector populations under treatment, the present method is of value in giving an insight into the potential of a vector population becoming resistant to a specific toxicant prior to the initiation of control operations. Thus, while the method is not designed and should not be used to compare the relative residual efficacy of compounds, it may be employed to detect the presence of a population segment

which is resistant to certain toxicants but not to others. Based on the genetic shift in populations under selection, the chances of critical resistance development in a species would appear to be greater in a population containing the genes responsible for this characteristic than in those from which the genes were absent.

ACKNOWLEDGMENT. These studies were accomplished as part of a contractual agreement between the Communicable Disease Center and the International Cooperation Administration, and in cooperation with the Division of Environmental Sanitation of the World Health Organization, Geneva, Switzerland. The Expert Committee on Insecticides of the World Health Organization at its VIIIth meeting recommended a standard procedure in which certain of these test principles are incorporated. A test kit based on this procedure is now being distributed by WHO.

References Cited

1. FAY, R. W., KILPATRICK, J. W., CROWELL, R. L., and QUARTERMAN, K. D. 1953. A method for field detection of adult mosquito resistance to DDT residues. *Bull. World Hlth. Org.* 9, 345-351.
2. BUSVINE, J. R., and NASH, RUTH. 1953. The potency and persistence of some new synthetic insecticides. *Bull. Ent. Res.* 44:371-376.

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TECHNIQUES TO GIVE BETTER HATCHES OF THE EGGS OF *Aedes aegypti* (L.) (DIPTERA: CULICIDAE)¹

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If fertilized *Aedes aegypti* eggs remain on a moist substrate for several days after oviposition, the embryos develop to maturity, and then remain dormant until a suitable hatching stimulus is applied. Shannon and Putnam (1934) found that ordinary distilled water would stimulate some of these dormant eggs to hatch, especially if they were less than 10 days old or had been moistened for several hours. Similarly, Granett and Haynes (1944) obtained good hatches in ordinary distilled water of eggs stored up to several weeks under humid conditions.

We found, however, that eggs from our colony of *A. aegypti* hatched very poorly in ordinary distilled water. Of other hatch-promoting stimuli reported in the literature, the reduction of dissolved oxygen in the hatching medium appeared to be one which might be put to good use for hatching eggs in the laboratory. Studies of the relation of egg hatching to low oxygen tensions were first made by Gjullin, Hegarty and Bollen (1941), and later by Borg and Horsfall (1953), Horsfall (1956), and Horsfall, Lum and Henderson (1958). With *A. aegypti*, Gjullin *et al.* found that the same stimulus to hatching was produced regardless of whether oxygen was removed by biological, chemical, or physical processes. They found that eggs 3 to 4 days old hatched about equally well in ordinary distilled water and in deoxygenated distilled water, but that deoxygenated water hatched more of older eggs. Recently, Barr and Al-Azawi (1958) have referred to the use of deoxygenated water to produce larvae of uniform age.

If an egg-hatching stimulus is to be used to best advantage, it is important that

eggs be stored so as to maintain a maximum viability. Marshall (1938) stressed that if eggs become too dry the embryos die, thus indicating that humidity could affect the viability of stored eggs. Although Granett and Haynes (1944) recommended that eggs be stored at a high humidity, in practice they are often stored at the ambient humidity of the laboratory. Thus, in addition to a study of the usefulness of reduced dissolved oxygen for hatching *A. aegypti* eggs in laboratory rearing procedures, the following investigation also includes studies of the effects of humidity on the viability of stored eggs.

MATERIALS AND METHODS. The eggs used were obtained from a colony of *A. aegypti* maintained on a 10 percent sucrose solution and allowed to take blood meals from a guinea pig twice weekly. The eggs were laid on filter paper placed on a pad of moist cellucotton in a Petri dish. They were kept moist for 3 days and then stored in the laboratory (except where otherwise stated) at 23–30° C. and 30–60 percent relative humidity.

Eggs were hatched in small glass dishes filled with water and covered with watch glasses, except in experiments on different types of hatching containers. At least 50 eggs were used for each test. With several exceptions, hatches were evaluated on the bases of the time from immersion to commencement of hatching and of the number of eggs hatching during the first hour. The one-hour period was chosen arbitrarily as a suitable period for hatching in any standardized procedure that might be developed.

For the experiments on egg storage and relative humidity, three levels of humidity were used as follows: 90–100 percent,

¹ Contribution No. 7, Entomology Laboratory, Research Branch, Canada Department of Agriculture, P.O. Box 248, Guelph, Ontario.

obtained by placing the eggs over moist cotton in a closed jar; 30-60 percent, obtained by keeping the eggs at the ambient humidity of the laboratory; and, 0-10 percent, obtained by placing the eggs over calcium chloride in a closed jar.

Dissolved oxygen was removed from distilled water by boiling the water for 30 minutes, then cooling it to 28-29° C. in the absence of air. This reduced the amount of dissolved oxygen in the distilled water from its normal value of 7-8 p.p.m. to less than 2 p.p.m. by weight. Determinations of dissolved oxygen were made by the Winkler method as described by the American Public Health Association (1947, pp. 124-139).

EXPERIMENTS AND RESULTS. A preliminary experiment with 13-day old eggs showed that ordinary distilled water hatched less than one percent of them in 45 minutes, whereas deoxygenated water (1.0 p.p.m. of dissolved oxygen) hatched 29 percent. The hatching of some eggs from 3 to 19 days old was then tested at a number of different levels of dissolved oxygen within the range of 1.0 to 7.9 p.p.m. As the amount of dissolved oxygen remaining in the water was increased, the percentage hatching in one hour generally decreased (Table 1). This was more marked in older eggs, those over six days old failing to hatch at 7 to 7.9 p.p.m. of dissolved oxygen.

As deoxygenated water gave good hatches of eggs from three to 19 days of age, the hatches of eggs in deoxygenated water were determined at intervals over

a greater range of age. The best hatches were obtained during the first week, thereafter there was a general decrease in hatch, and by the 86th day eggs no longer hatched when immersed for one hour in deoxygenated water (Figure 1). Also, the time from immersion until commencement of hatching steadily increased during the experiment (Figure 1).

Next, the effect of humidity on the viability of stored eggs was determined. Some eggs from a large sample three days old were tested for hatching in deoxygenated water, and the remainder were divided into three groups which were stored at 90-100 percent, 30-60 percent, and 0-10 percent relative humidity respectively. In subsequent tests, the eggs stored at higher humidities gave better hatches, hatched more quickly and maintained viability longer than those stored at lower humidities (Figure 2). These differences were significant at the five percent level of probability.

Finally, as it was clear that even eggs several months old would give good hatches if they were stored at a high humidity and then immersed in deoxygenated water, tests were made of the efficiency of two types of hatching containers, large enough to hatch at least 500 eggs. The dissolved oxygen content of deoxygenated water poured into open enamel photographic pans, which are often used for mosquito rearing, increased from 1.9 to 8.0 p.p.m. in the one-hour hatching period. By contrast, a corresponding increase of only 0.6 p.p.m. of dissolved

TABLE 1.—Percentages of *A. aegypti* eggs of different ages that hatched in one hour in distilled water containing various amounts of dissolved oxygen, 50 eggs being used per test

Age, days	Dissolved oxygen, p.p.m.					
	1-1.9	2-2.9	3-3.9	4-4.9	5-5.9	7-7.9
3	62	44	50	—	38	38
4	52	62	—	46	44	4
5	74	—	—	10	—	0
6	86	54	38	—	22	6
7	72	60	—	6	—	0
13	56	22	18	—	8	0
19	74	50	2	—	0	0

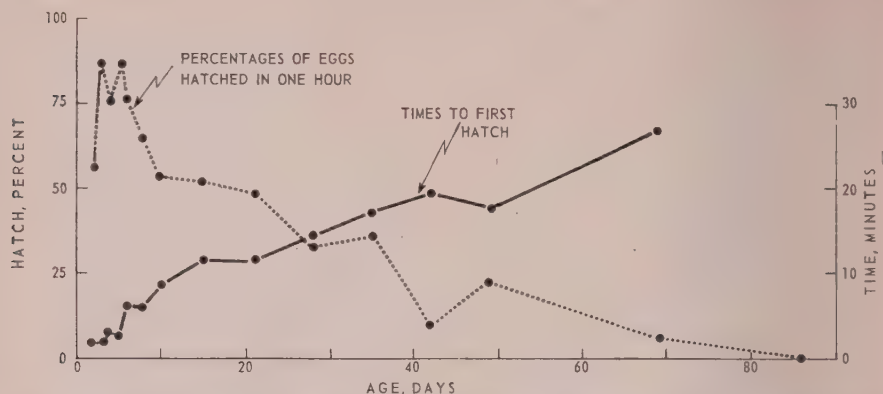


FIG. 1.—Percentages of *A. aegypti* eggs of various ages that hatched in one hour in deoxygenated distilled water (i.e., 0.6 to 1.4 p.p.m. of dissolved oxygen), and times required for hatching to commence, after storage at 30–60 percent relative humidity

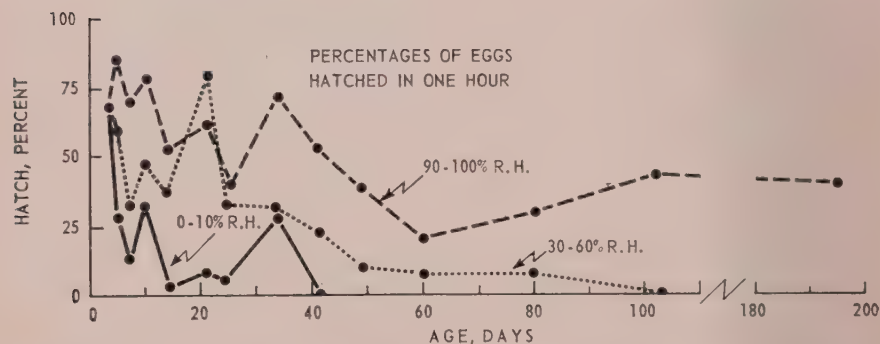
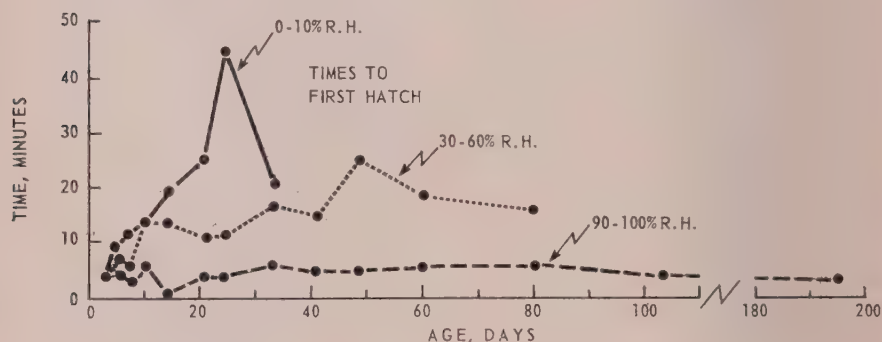


FIG. 2.—Percentages of *A. aegypti* eggs of various ages that hatched in one hour in deoxygenated distilled water (i.e., 0.6 to 1.3 p.p.m. of dissolved oxygen), and times required for hatching to commence, after storage at three different levels of relative humidity

oxygen was found in deoxygenated water in completely filled, unstoppered, 250 cc. reagent bottles. Subsequent tests showed that the bottles hatched about three times as many eggs as the open pans in a one-hour hatching period. The restricted size of the water surface exposed to air in the bottles appeared to have no adverse effect on the newly hatched larvae.

DISCUSSION. The effectiveness of deoxygenated water in stimulating *A. aegypti* eggs to hatch, as first described by Gjullin *et al.* (1941) is wholly supported by the foregoing experiments. In the experiments on maintenance of egg viability, the decrease in hatch with advancing age of eggs stored at the ambient humidity of the laboratory can be attributed partly to drying of the eggs. Other factors must also contribute to this decline in viability as even eggs stored at 90 to 100 percent humidity still showed some decline in viability with advancing age. The longer time required for hatching to begin, of those eggs stored at lower humidities, may be due to drying of the chorion, or to direct effects on the unhatched larvae.

The following procedures were adopted for handling and hatching eggs. Oviposition dishes with eggs were removed from the cages daily, placed in a closed container for 24 hours, and then exposed in the rearing room (approximately 60 percent relative humidity) for the next 48 hours. During the last half of this 48-hour period, the filter paper was loosened slightly from the underlying cellulocotton. The filter paper discs, with eggs attached, were then stored over moist cotton in a closed glass jar until used. Hatching was carried out in narrow-necked 250 cc. reagent bottles. The required number of egg papers were rolled up and inserted into a bottle full of freshly boiled distilled water at a temperature of 28–29° C., and with a dissolved oxygen content of approximately 1.2 p.p.m. The bottle was left

unstoppered, and the hatched larvae were carefully poured into rearing trays at the end of one hour.

CONCLUSIONS. Immersion in distilled water containing less than 2 p.p.m. of dissolved oxygen was shown to be a very efficient procedure for hatching *A. aegypti* eggs for laboratory rearing. Increasing the humidity at which eggs were stored increased and prolonged their viability and caused them to start hatching more quickly in deoxygenated water. Containers which exposed little surface of deoxygenated water to the air were most efficient for hatching eggs.

References Cited

- AMERICAN PUBLIC HEALTH ASSOCIATION. 1947. Standard methods for the examination of water and sewage. 9th ed., 2nd printing.
- BARR, A. R. and AL-AZAWI, A. 1958. Notes on oviposition and the hatching of eggs of *Aedes* and *Psorophora* mosquitoes (Diptera: Culicidae). Univ. Kansas Sci. Bull. 39(6):263–273.
- BORG, A. F. and HORSFALL, W. R. 1953. Eggs of floodwater mosquitoes. II. Hatching stimulus. Ann. Ent. Soc. America 46(4):472–478.
- GJULLIN, C. M., HEGARTY, C. P. and BOLLEN, W. B. 1941. The necessity of low oxygen concentration for the hatching of *Aedes* mosquito eggs. J. Cell. and Comp. Physiol. 17(2): 193–202.
- GRANETT, P. and HAYNES, H. L. 1944. Improved methods of rearing *Aedes aegypti* mosquitoes for use in repellent studies. Proc. New Jersey Mosquito Exterm. Assoc. 31:161–168.
- HORSFALL, W. R. 1956. Eggs of floodwater mosquitoes (Diptera, Culicidae) II. Conditioning and hatching of *Aedes vexans*. Ann. Ent. Soc. America. 49(1):66–71.
- HORSFALL, W. R., LUM, P. T. M., and HENDERSON, L. M. 1958. Eggs of floodwater mosquitoes (Diptera: Culicidae) V. Effect of oxygen on hatching of intact eggs. Ann. Ent. Soc. America 51(2): 209–213.
- MARSHALL, J. F. 1938. The British mosquitoes. London: British Museum of Natural History. 341 pp.
- SHANNON, R. C., and PUTNAM, P. 1934. The biology of *Stegomyia* under laboratory conditions. I. The analysis of factors which influence larval development. Proc. Ent. Soc. Wash. 36(7): 185–216.

SELECTIVE RESPONSE OF *Aedes nigromaculis* (LUDLOW) TO THE MINNESOTA LIGHT TRAP

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Preliminary studies on comparative mosquito catches by American Model (Mulhern, 1953) and Minnesota (Frost, 1952) light traps were reported by Loomis (1958). The studies showed the Minnesota trap collected almost exclusively *Aedes nigromaculis* (Ludlow). Additional tests were conducted to confirm these results, to determine the efficiency of the Minnesota trap at high light intensities, to compare Minnesota and motorless American traps, and to compare collections between Minnesota traps of different size.

MATERIALS AND METHODS. The so-called Minnesota trap was originally designed and used at the University of Minnesota to collect adults of the European corn borer, *Pyrausta nubilalis* Hübner. Hodson (*in litt.*) reported that details of trap design were not available at the University. Construction of the traps, therefore, was after the design shown by Frost (1952). The trap operates without a motor and fan but has a light bulb placed between four reflector plates (baffles) contained within a top hood and funneled bottom (Figure 1). The top and bottom are isometric (16-inch diameter), of 20-gauge galvanized iron, and each contains a sheet metal divider bolted to the spacing rods. The top and bottom are separated by a distance of one foot. Narrow strips of sheet metal, bent to form a groove and spot-welded to the spacing rods, serve to hold the removable aluminum baffles. The baffles are fastened to the dividers by means of sheet metal screws. Insects are collected in a killing jar which is attached to the funnel-shaped bottom. An electric timer may be bolted to the top hood if desired. A one-quarter inch mesh wire screen is placed around the spacing rods to prevent entry of large insects. This model of the trap

is designated the large type. A small model was also constructed by making the spacing rods 10 inches long, rather than 14 inches.

Field tests were conducted from July to October in two rural locations in the Central Valley of California. At one location an American trap was compared with a large Minnesota trap. The traps were placed two feet from the wooden walls of a pump house; one was on the south side and the other on the east. A bluff, 150 feet high, was immediately west of the pump house and an irrigated pasture not under mosquito control was immediately east by southeast. Three tests were conducted: A, in which both traps operated with 50-watt lamps; B, in which the Minnesota trap was provided with a 100-watt lamp in order to determine whether the catch of this trap could be increased to equal that of the American trap operating with a 50-watt lamp; C, in which the catch of a motorless American trap was compared with that of a Minnesota trap while both traps operated with 50-watt lamps. The traps were interchanged in position once during test A and at regular intervals during tests B and C.

A large and a small Minnesota trap were placed 20 feet apart under a *Eucalyptus* tree at a second location; one position was on the north side and the other on the east side. Dense foliage obscured the traps from each other. Traps were interchanged in position at frequent intervals and both operated with 50-watt lamps. Urban development was immediately west and south while an irrigated pasture subject to mosquito control was immediately northeast.

All traps were placed six feet above the ground and operated 12 hours each night beginning at 6:00 or 7:00 p.m. Two varie-

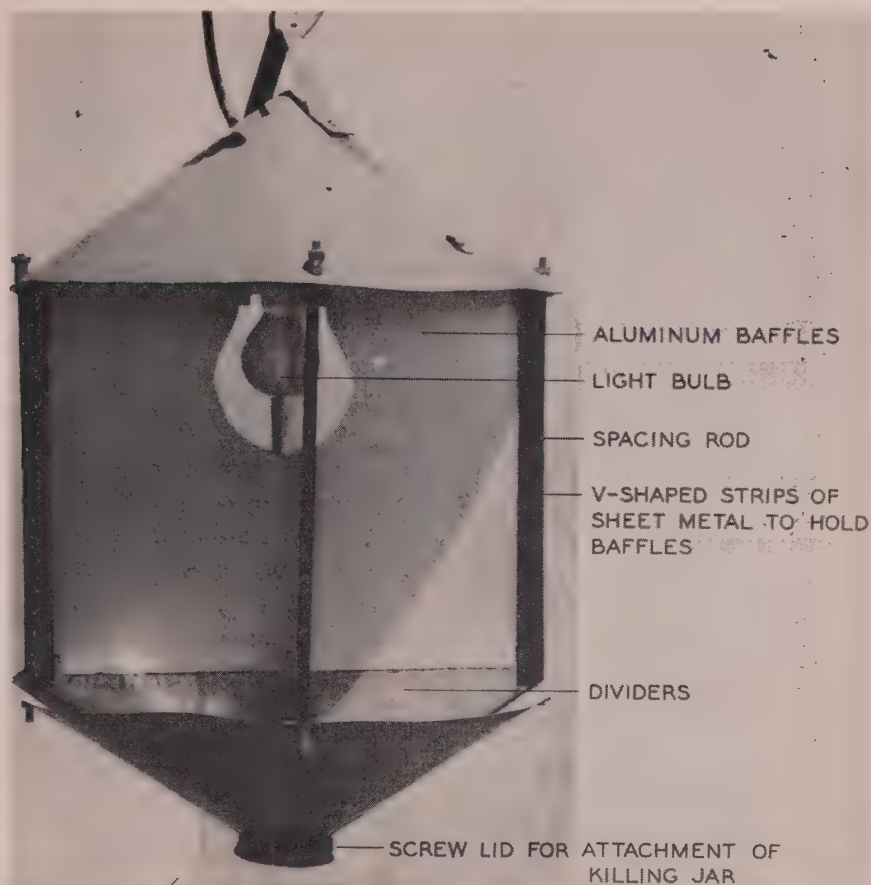


FIG. 1.—Modified Minnesota light trap.

ties of inside-frosted white lamps were used, a 50-watt (60 foot candles), vibration-service type, and a plain 100-watt (105 foot candles).

RESULTS. In Test A (Table 1) the American trap caught more *A. nigromaculis* of both sexes than did the Minnesota trap during the first 13 nights. When the traps were reversed in position for another 13 nights the American trap collected as many males and three times as many females of this species as the Minne-

sota trap. Although the American trap caught more mosquitoes than did the Minnesota trap, the total trap catches contained 61 percent and 98 percent *A. nigromaculis* respectively. Only the American trap caught considerable numbers of *Aedes melanion* Dyar and *Culex tarsalis* Coquillett.

By increasing the luminosity in the Minnesota trap in Test B (Table 1), more males of *A. nigromaculis* were taken in this trap than in the American trap. With

TABLE 1.—Number of *Aedes nigromaculis* per trap night¹ in American and Minnesota light traps operated under three sets of conditions at one location, California, 1958

Inclusive dates	Trap position ²	Males	Females	Trap position ²	Males	Females
Test A		American trap (50 watt lamp)		Minnesota trap (50 watt lamp)		
July 15-27	South	27	50	East	6	9
August 1-13	East	2	18	South	2	6
Test B		American trap (50 watt lamp)		Minnesota trap (100 watt lamp)		
August 14-17	East	103	229	South	170	43
August 18-21	South	8	104	East	26	35
August 22-24	East	9	142	South	29	157
August 25-27	South	9	51	East	96	97
August 28-31	East	0	33	South	2	20
September 1-4	South	2	37	East	5	17
Test C		American trap (50 watt lamp, motorless)		Minnesota trap (50 watt lamp)		
September 10	South	0	0	East	10	2
September 11	East	0	1	South	18	8
September 15-16	South	96	16	East	130	28
September 19-20	East	10	12	South	70	62
September 21	South	6	9	East	21	24
September 23-24	East	0	0.0 ^a	South	2	4
September 25-28	South	0.0	4	East	0.0	6
Sept. 29-Oct. 2	East	0.0	4	South	2	3
October 3-5	South	0	3	East	3	6
October 6-7	East	0.0	0.0	South	1	1

¹ Rounded to nearest whole number.² See text.^a Less than five-tenths.

females, however, the American trap generally caught more than did the Minnesota trap. In this test 99 percent of the catch of the Minnesota trap was *A. nigromaculis* and 72 percent of the catch of the American trap was of this species. Large numbers of *A. melanimon* and *C. tarsalis* were again taken only in the American trap. Many more *Aedes vexans* (Meigen) and *Culex peus* Speiser were also caught by the American than by the Minnesota trap.

In Test C (Table 1) the Minnesota trap consistently caught more males and females of *A. nigromaculis* than did the motorless American trap. The proportion

of this species in the total collections of the two traps were 96 and 88 percent, respectively. *A. melanimon* was again more common in the catch of the American trap.

In general, collections from both traps showed similar population trends for each sex of *A. nigromaculis*. Peak densities occurred during the latter part of August and in the middle of September.

The comparative data on the relative catches of the large and small Minnesota traps were variable due to the bias of one trap position. It was evident, however, that the two traps caught an approximately

equal number of males and females of *A. nigromaculis*. The total catch of both traps was close to 98 percent *A. nigromaculis* while *C. tarsalis* and *A. melanimon* were taken in extremely low numbers.

DISCUSSION. Although the experimental design of this study took into consideration the factor of trap position, a rotary trap device similar to that described by Dow *et al.* (1957) is preferable in tests of this type in order to randomize the position factor and other variables which affect the relative numbers of mosquitoes captured. The present technique, however, was adequate for determining gross differences in performance resulting from variations in trap design and operation.

In the previous study (Loomis, 1958) the Minnesota trap collected chiefly *A. nigromaculis*, but generally a smaller total number of mosquitoes than did the American trap. The present study confirms these results. When light intensities of the Minnesota trap were increased, larger numbers of *A. nigromaculis* were taken, approximating collections made by the American trap. The two traps were further compared by turning off the fan and motor in the American model; under these conditions the Minnesota trap consistently caught more *A. nigromaculis* than did the American trap. This result may be due to the pattern of lighting produced by the two traps. The American trap illuminates a small circle on the ground beneath the trap while the Minnesota trap projects a wide horizontal beam of light. These and other results suggest that *A. nigromaculis* is highly attracted to light. In preliminary tests made with American light traps operated without light and with light of varying intensities, this species was more positively phototropic than either *C. tarsalis* or *Culex pipiens* Linnaeus (broad sense) (Loomis, unpublished). Reed (1959) also reported that *A. nigromaculis* was collected in light traps (with 25-watt white bulbs) only when the light operated.

Since the Minnesota trap is highly selective for *A. nigromaculis* it should be a useful device for studies of adult population trends of this species. Limiting the trap catch in terms of species results in collections that are more easily processed. Also, the construction cost of the trap is considerably less than that of fan operated traps. The Minnesota trap, however, is not recommended for the collection of any of the several other species collected in the course of this study.

SUMMARY AND CONCLUSIONS. A light trap was constructed from an illustration of the Minnesota trap originally designed to collect European corn borers. This trap, which essentially utilizes a light bulb placed between four reflector plates contained within a top hood and funnel-shaped bottom, was tested against a fan operated American Model trap commonly used to collect adult mosquitoes in California. The Minnesota trap collected *Aedes nigromaculis* almost exclusively, although in smaller numbers than did the American trap. The collection of *A. nigromaculis* by the Minnesota trap can be increased by increasing the light intensity. The pattern of lighting in the Minnesota trap is apparently more selective for *A. nigromaculis* than that in the American trap. Two Minnesota models which differed in size performed about equally well.

References Cited

- FROST, S. H. 1952. Light traps for insect collection, survey and control. Penn. State College, Agric. Exp. Sta. Bul. 550, 32 pp.
- DOW, R. P., REEVES, W. C., and BELLAMY, R. E. 1957. Field tests of avian host preference of *Culex tarsalis* Coq. Amer. Jour. Trop. Med. and Hyg. 6:294-303.
- HODSON, A. C. 1958. Personal communication. University of Minnesota.
- LOOMIS, E. C. 1958. A potential *Aedes nigromaculis* light trap. Proc. and Papers 26th Ann. Conf. Calif. Mosq. Contr. Assoc., pp. 87-88.
- MULHERN, T. D. 1953. Better results with mosquito light traps through standardizing mechanical performance. Mosquito News, 13:130-33.
- REED, D. E. 1959. Mosquito light trap catches without the benefit of light. Proc. and Papers 27th Ann. Conf. Calif. Mosq. Contr. Assoc., pp. 63-66.

THE MOSQUITOES OF TURKEY

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A survey of arthropods of public health significance occurring in Turkey was begun in April 1958 by the Entomology Service of the United States Air Force's Fourth Epidemiological Flight. This survey was conducted over a period of thirteen (13) months. Included in the survey were mosquitoes, sand flies, deer flies, horse flies, stable flies and ticks. It is the purpose of this paper to present information on the species of mosquitoes found in Turkey and their topographical distribution.

Turkey is situated between 36° and 42° north latitude, and between 26° and 55° east longitude. It is bounded by the Black Sea on the north, by the Russian Caucasus on the northeast, by Iran on the east, by Iraq, Syria and the Mediterranean Sea on the south, by Greece and the Aegean Sea on the west and by Bulgaria on the northwest. There are 4,429 miles of coastline, deeply indented and fringed with islands along the Aegean Sea. The area of Turkey is 296,503 square miles, 96.88 percent of which lies in Asia and the remaining 3.12 percent in Europe. Turkey-in-Europe is divided from Turkey-in-Asia by the Dardanelles, the Sea of Marmara and the Bosphorus. The European portion of Turkey is about the size of New Hampshire, while the Asiatic portion is somewhat larger than the combined areas of Pennsylvania, Virginia, West Virginia, Ohio, Indiana and Illinois.

Topographically Turkey is divided into four areas—Coastal Plain, Anatolia, Eastern Anatolia and Southeast Anatolia (Figure 1). The approximate altitudes for

the respective areas are as follows: 0-656 feet, 1,640-5,000 feet, 5,000-16,696 feet and 656-3281 feet. The coastal plain area comprises approximately 10 percent of the land area of Turkey. Along the Black Sea portion of this plain the rainfall is ample and the temperature is cool, while the Mediterranean area is semi-tropical and humid. Along the Marmara, Aegean and Mediterranean coastal plains there is little rainfall in the summer, fall and winter. The Anatolia area comprises more than half of the land area of Turkey and is made up of saucer-shaped plateau ranges from 1,640 to 5,000 feet high with scattered minor groups of mountains in the interior. This area is similar to the arid plateaus east of the Rocky Mountains in the United States. The winters are cold and the summers are hot with cool breezy nights. There is practically no rainfall in this area during the summer. There are numerous brackish marshes and lakes present which provide breeding areas for mosquitoes during this period. Eastern Anatolia consists of one mountain range after another with Mt. Ararat soaring to 16,696 feet. The winters are very cold in this area with considerable snowfall. Annual precipitation ranges around 19 inches. The Southeast Anatolia area comprises a foothill region where the mountains of eastern Anatolia fall off to the south to the rolling hill country of Syria, Iraq and Iran. The summers are extremely hot and dry.

This survey was accomplished by the author, one Preventive Medicine Supervisor and two Preventive Medicine Specialists, respectively. The services of a Veterinary Technician were available on a part-time basis. Either a jeep or weapons carrier was used for transportation. Equipment contained in the Entomological Survey Set, Federal Stock Number 6545-919-5600 and a New Jersey mosquito light

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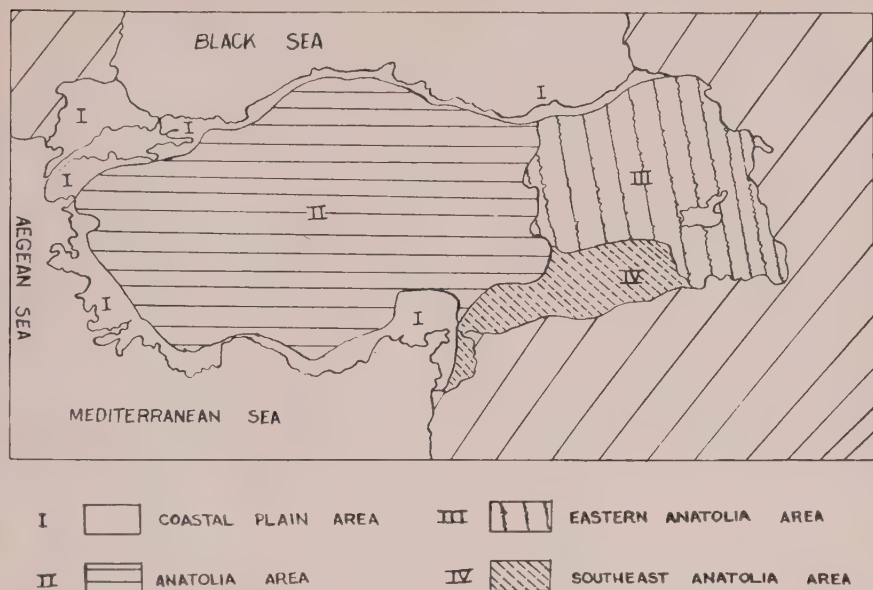


FIG. 1.—Map of Turkey showing the four topographical areas.

trap were utilized in conducting the survey. The facilities of the Regional Malaria Control Offices, Turkish Ministry of Health and Social Assistance,² located in the Izmir, Bursa, Seyhan (Adana), Diyarbakir and Antalya Provinces were also utilized in conducting this survey.

Adult specimens were collected in natural resting sites including dwellings in native villages, parked and moving vehicles, light traps and by net sweepings. The employment of light traps in this survey marks the first time this collection

technique has been reported used in Turkey. Larval specimens were collected in permanent streams of water and lakes as well as temporary breeding places including irrigation ditches, marshes, artificial containers and tree holes.

Following is a list of the species and infraspecific forms collected and their distribution in the four topographical areas of Turkey. I—denotes Coastal Plain Area, II—Anatolia Area, III—Eastern Anatolia Area and IV—Southeast Anatolia Area. A total of 55 species are recorded, representing 7 genera.

Genus *Anopheles* Meigen

1. *Anopheles* (*Anopheles*) *algeriensis* Theobald I-II-III-IV
2. *Anopheles* (*Anopheles*) *claviger* (Meigen) I-II-III-IV
3. *Anopheles* (*Anopheles*) *hyrcanus* (Pallas) I-II-III
4. *Anopheles* (*Anopheles*) *maculipennis* Meigen I-II-III-IV

²The author is indebted to Dr. Alan Stone, United States Department of Agriculture, Agricultural Research Service, Entomology Research Division, U. S. National Museum, to Dr. Mahmut Akalin, former Director of the Malaria Institute, Turkish Ministry of Health and Social Assistance, Adana, Turkey for verification of identification of species, to Dr. Sevkett Ogen, General Director of Malaria Control, Turkish Ministry of Health and Social Assistance who authorized the Regional Malaria Control Directors to make their facilities available to the survey team, and to T/Sergeant William D. Phelps, USAF, who assisted the author in conducting this survey.

5. *Anopheles (Anopheles) maculipennis melanoon* Hackett I-II-III-IV
6. *Anopheles (Anopheles) maculipennis messeae* Falleroni I-II-III-IV
7. *Anopheles (Anopheles) marteri* Senevet and Prunelle I-II
8. *Anopheles (Cellia) multicolor* Camboulieu I
9. *Anopheles (Anopheles) plumbeus* Stephens I-II-III
10. *Anopheles (Anopheles) sacharovi* (Favb) I-II-III-IV
11. *Anopheles (Cellia) sergenti* (Theobald) I
12. *Anopheles (Anopheles) sinensis* Wiedemann I-II-III
13. *Anopheles (Cellia) superpictus* Grassi I-II-III-IV

Genus *Aedes* Meigen

14. *Aedes (Stegomyia) aegypti* (Linnaeus) I
15. *Aedes (Ochlerotatus) annulipes* (Meigen) I
16. *Aedes (Ochlerotatus) caspius* (Pallas) I-II
17. *Aedes (Aedes) cinereus* Meigen I
18. *Aedes (Ochlerotatus) detritus* (Haldy) I
19. *Aedes (Ochlerotatus) dorsalis* (Meigen) II
20. *Aedes (Finlaya) echinus* (Edwards) I-II-III
21. *Aedes (Ochlerotatus) excrucians* (Walker) II
22. *Aedes (Ochlerotatus) lepidonotus* Edwards I-II
23. *Aedes (Ochlerotatus) mariae* (Sergent and Sergent) I
24. *Aedes (Ochlerotatus) nigrocanus* Martini I
25. *Aedes (Finlaya) geniculatus* (Oliver) I-II
26. *Aedes (Ochlerotatus) pulchritarsis* (Rondani) I-II
27. *Aedes (Ochlerotatus) refikii* Medjid I
28. *Aedes (Ochlerotatus) rusticus* var *subtrichurus* Martini I
29. *Aedes (Ochlerotatus) flavescens* (Muel-ler) I-II
30. *Aedes (Aedimorphus) vexans* (Meigen) I-II-III

31. *Aedes (Ochlerotatus) rusticus* (Rossi) I-II
32. *Aedes (Ochlerotatus) communis* (De-Geer) I

Genus *Culex* Linnaeus

33. *Culex (Neoculex) apicalis* Adams I
34. *Culex (Neoculex) hortensis* Ficalbi I-II-III
35. *Culex (Culex) laticinctus* Edwards I
36. *Culex (Culex) mimeticus* Noe I-II
37. *Culex (Barraudius) modestus* Ficalbi I-II
38. *Culex (Culex) pipiens* Linnaeus I-II-III-IV
39. *Culex (Neoculex) martinii* Medjid I
40. *Culex (Lasiosiphon) adairi* Kirkpatrick I
41. *Culex (Barraudius) pusillus* Macquart I
42. *Culex (Culex) quinquefasciatus* Say I
43. *Culex (Culex) univittatus* Theobald I-II
44. *Culex (Neoculex) deserticola* Kirkpatrick I
45. *Culex (Culex) theileri* Theobald I-II
46. *Culex (Culex) vagans* Wiedemann I-II-III-IV
47. *Culex (Culex) torrentium* Martini I
48. *Culex (Culex) tritaeniorhynchus* Giles I-II-IV

Genus *Culiseta* Felt

49. *Culiseta (Culiseta) annulata* (Schrank) I-II-III
50. *Culiseta (Culicella) fumipennis* (Stephens) I
51. *Culiseta (Allotheobaldia) longiarreolata* (Macquart) I-II-III-IV
52. *Culiseta (Culicella) morsitans* (Theobald) I-IV

Genus *Mansonia* Blanchard

53. *Mansonia (Coquillettidia) richardii* (Ficalbi) I-II

Genus *Orthopodomyia* Theobald

54. *Orthopodomyia pulchripalpis* (Rondani) I

Genus *Uranotaenia* Lynch and Arribalzaga

55. *Uranotaenia unguiculata* Edwards I-II-III-IV

OBSERVATIONS ON *CULISETA MORSITANS* IN THE LANDSTUHL/PFALZ AREA OF GERMANY 1956-59¹

JOSEPH E. WEBB, JR., JOHN B. BARTON, RAYMOND C. LINTS AND EDWIN L. SHEPHERD

Several mosquito species of the genus *Culiseta* have been shown to be potential vectors of the viruses of human encephalitides. Some of these, including *Culiseta morsitans* (Theobald) are thought to feed primarily on birds or other small animals and may possibly fill a connecting link in the little-understood epidemiology of various human virus infections.

Wesenberg-Lund (1) in Denmark and Marshall (2) in England report that they never have been able to induce laboratory reared females of *C. morsitans* to feed on man. Natvig (3) cites a reference where Eckstein claims to have induced a female of this species to feed on blood of a greenfinch, indicating that the species probably feeds on birds.

Carpenter and La Casse (4) report the distribution of *C. morsitans* as Northern United States, Alaska, Canada and Europe, the larvae occurring in rather large, temporary, cold rain-water pools in both shaded and open marshes. Various European workers have recorded the species as having a wide distribution in Europe, including France, England, Denmark and other areas; however, very meager information is found in the literature on its biology, seasonal occurrence, specific larval habitats and ecologic association with other mosquito species.

In the course of conducting routine surveys for mosquito species occurring in the southwest area of Germany during 1956, 1957, 1958 and early 1959, some habitats were observed in the Landstuhl/Pfalz area in which larvae of *C. morsitans* were collected during most months of the year. The two habitats from which larvae were most consistently collected and in greatest numbers were quite similar to each other. Both were ditches about two

to three feet deep with sloping sides, being partially shaded by trees and/or low-growing vegetation, and separated by a dirt road from a field. Both held rain-water and seepage water almost the year around. One (Figure 1) was located along the edge of Landstuhl Air Base on level ground at an altitude of about 760 feet above sea level. The other was about 1/2 mile south of the above on low-lying, level ground at about the same elevation. One other place where larvae were occasionally found was a temporary woods pool, about 3 miles west of the above places, containing rain-water.

Current records indicate that hatching of *C. morsitans* takes place in August, after which either second, third or fourth instar larvae may be found in each ensuing month until about May. Pupae were field collected in March and May. No stage of the species was collected during the warmer season of June and July. It is therefore assumed that the adults emerge during March to May and deposit eggs which do not hatch until August, or else the adults survive the summer and deposit their eggs in late summer, as observed by Marshall (2) in England. The species overwinters in the larval stage and there apparently is only one generation per year. The larvae survive low temperatures under the ice and snow.

Table 1 contains summarized records of ten other species of mosquitoes including seven of the genus *Aedes*, one *Anopheles*, one *Culex* and one other *Culiseta* collected from the same larval habitats with *C. morsitans*.

Adults of *C. morsitans* were never collected in the field in biting collections or otherwise.

During the winter, in early 1958, an attempt was made to establish a laboratory colony of *C. morsitans*. On 8 January, about 180 third and fourth instar larvae

¹A contribution of the Entomology Department, U. S. Army, Europe, Medical Laboratory, APO 180, New York, New York.

TABLE 1.—Summary by months of larvae of *C. morsitans* and/or associated species taken from breeding sites in Landstuhl, Germany Area 1956-1959

Month of collection	Total No. of collections	Number & instar of <i>C. morsitans</i> taken		Other species taken with <i>C. morsitans</i>	Water temperature ranges at times of collections and other remarks
		1st instar	2, 3 & 4th instar		
August	3	21	0	<i>Culex pipiens</i> , <i>Aedes vexans</i> <i>Aedes cantans</i> , <i>Aedes cinereus</i> <i>Aedes punctor</i>	60° to 70° F.
September	3	0	32	<i>Culex pipiens</i> , <i>Aedes punctor</i> <i>Aedes cantans</i> , <i>Aedes cinereus</i> <i>Aedes vexans</i>	58° to 60° F.
October	9	0	221	<i>Culex pipiens</i> <i>Culiseta annulata</i>	50° to 56° F.
November	4	0	71	None	40° to 46° F.
December	3	0	43	None	1 to 2 inches of ice on water
January	5	0	428	<i>Aedes rusticus</i>	3 to 4 inches of ice on water
February	4	0	337	<i>Aedes rusticus</i>	34° to 46° F.
March	5	0	82	<i>Aedes rusticus</i> <i>Aedes communis</i> <i>Aedes punctor</i> <i>Aedes cantans-annulipes</i>	38° to 54° F. 14 field collected pupae reared in lab. to adult <i>C. morsitans</i>
April	10	0	47	<i>Aedes rusticus</i> , <i>Aedes punctor</i> <i>Aedes communis</i> , <i>Aedes cantans-annulipes</i> <i>Anopheles claviger</i>	44° to 58° F.
May	3	0	3	<i>Aedes punctor</i> , <i>Culex pipiens</i> <i>Aedes cantans-annulipes</i> <i>Aedes cinereus</i>	38° to 65° F. 1 field coll. pupa reared in lab. to adult <i>C. morsitans</i>
June	1	0	0	<i>Aedes cantans-annulipes</i>	65° F.
July	2	0	0	<i>Culex pipiens</i> <i>Aedes vexans</i> <i>Aedes cinereus</i>	58° to 70° F.

were collected from under about four inches of ice, put in a two-gallon glass animal jar and kept in the laboratory at room temperature. The larvae were kept in some of the ditch water and fed on powdered dog food and yeast mixture. As the larvae began pupating about 1 February, they were transferred into a large, white, enamel pan inside a 15" x 15" x 15" screen cage. Adults began emerging on 6 February. During February, additional larvae were field collected and added to the glass jar and used as a continuous supply of pupae for adult

emergence in the cage. Repeated attempts made to induce the females to feed on human blood by inserting the hand and forearm into the cage failed. Also in February, newly hatched chickens and very young white mice were placed in the cage, but none of the adult mosquitoes were observed to take blood. The males, and possibly the females also, fed on pieces of apple and also on sugar solution, suspended from the top of the cage. Daily observations were made to determine whether oviposition was occurring. Later a block of damp earth, from the edge of



FIG. 1.—Shaded ditch separating old road and a field, adjacent to Landstuhl Air Base, Germany where *C. morsitans* larvae were collected each month in the year except June and July.

the ditch from which the larvae were taken, was placed in one end of the pan of water as additional inducement for egg laying. No oviposition was ever recorded.

References Cited

1. WESENBERG-LUND, C. 1920-1921 Contributions to the biology of the Danish culicidae. Copenhagen: A. F. Høst & Son, 210 pp.
2. MARSHALL, J. F. 1938. The British mosquitoes. London: British Museum of Natural History, 341 pp.
3. NATVIG, L. R. 1948. Contributions to the knowledge of the Danish and Fennoscandian Mosquitoes: Culicini. Norsk. Ent. Tidsskr., Sup. 1, 567 pp.
4. CARPENTER, S. J. AND LA CASSE, W. J. 1955. Mosquitoes of North America. University of California Press, Berkeley-Los Angeles, 360 pp.

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EXPANSION OF EGGS OF *CULEX TARSALIS* COQUILLET AND *AEDES NIGROMACULIS* (LUDLOW) (DIPTERA: CULICIDAE)

BETTINA ROSAY

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Water absorption in arthropod eggs usually takes place during embryonic development (Edney, 1957; Wigglesworth, 1950). The process of water absorption can be studied indirectly by measuring the change in size of eggs after they are laid. This type of investigation has previously been done for mosquito eggs by Downs (1951) and Gander (1951). The present study is an extension of their works and is intended to provide a foundation for the study of the permeability of eggs to insecticides.

MATERIALS AND METHODS. *Culex tarsalis* eggs were obtained from a laboratory colony (Bakersfield strain) maintained at the State Department of Public Health Field Station in Fresno. Groups of eggs were separated from newly-laid rafts and placed individually in a horizontal position in rows on a strip of filter paper. The paper strip, wet with distilled water, was supported by a glass slide. Measurements of length and width of eggs were made at intervals until hatching occurred. Measurements were made with a compound microscope fitted with an ocular micrometer. To test the effect of an environment of limited moisture, newly-laid eggs were drained briefly on absorbent paper, then submerged in mineral oil (Nujol) for subsequent measurements. Eggs from the same rafts were kept on wet filter paper for controls. In all tests the normal hatching time was determined by the unused portion of each raft which was left in the usual upright position on a water surface. In all tests the developmental times of control and test eggs were the same. Infertile *C. tarsalis* eggs were easily differentiated from embryonated eggs by observing the state of development through the transparent shells.

Aedes nigromaculis eggs were obtained in the laboratory from field-caught females captured in the Fresno area. These eggs were kept in the same manner as described above; only lengths of eggs were measured. After 80 hours of incubation the shells of these eggs were bleached with sodium hypochlorite so that embryonated eggs could be distinguished from infertile ones.

Initial measurements were made when the eggs were less than one hour old; at this age the eggs were white. Final measurements of *C. tarsalis* were made immediately before hatching of fertile eggs which took place 30 to 33 hours after oviposition. For *A. nigromaculis*, final measurements were made 76 hours after oviposition.

Except where otherwise specified, the eggs were incubated at 90° F.

All data were analyzed statistically, and statements of significance are based on a chance probability of less than one in one hundred.

RESULTS. Measurements of *C. tarsalis* eggs are shown in Table 1. If the egg is considered to be a prolate spheroid, the initial and final volumes can be calculated to be 0.0065 mm³ and 0.0124 mm³ respectively, which is a change in volume of 47.5 percent. Weighings were made to estimate the weight changes and densities of eggs, but the results were inconclusive due to technical difficulties.

C. tarsalis eggs from the same raft exhibited similar magnitudes of expansion when incubated at different temperatures. The rates of expansion, however, were influenced by temperature as shown in Figure 1. There was a direct relationship between temperature and rate of expansion. In a refrigerator at 40° F. lengthening of the eggs took place very slowly;

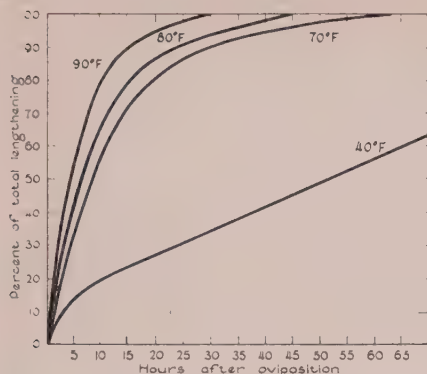


FIG. 1.—Change in length of *Culex tarsalis* eggs at different temperatures.

six to ten days were required for these eggs to reach a size comparable to eggs incubated at warmer temperatures.

There was no significant difference in initial lengths of fertile and infertile eggs (Table 1). Since lengthening occurred in infertile as well as fertile eggs embryonic development was not necessary for expansion. A comparison of lengths of fertile and infertile eggs at 30 hours after oviposition showed that in the same period of time infertile eggs had become significantly longer. The expansion of infertile eggs was 4.8 percent greater than fertile eggs (Figure 2).

Some newly-laid *C. tarsalis* eggs were placed in mineral oil to restrict water uptake. Lengths of eggs in oil were compared with eggs that had developed on wet filter paper. In the absence of excess water eggs lengthened 6.1 percent less than the control eggs (Table 1). Very few of the eggs submerged in oil embryonated in a normal manner; many were abnormal and many did not undergo any embryonic development. Control eggs from the same rafts which were incubated on wet filter paper developed normal embryos. The factors that limited embryogenesis of eggs submerged in oil were not determined. A comparison of eggs from this control group

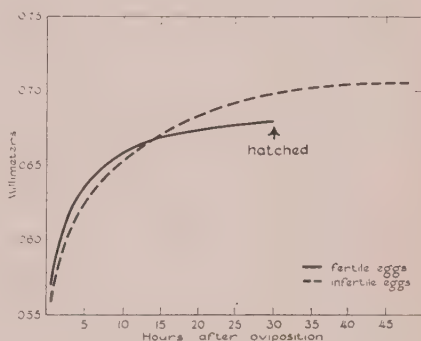


FIG. 2.—Change in length of *Culex tarsalis* eggs after oviposition (90° F.).

TABLE 1.—Size increases of eggs of *Culex tarsalis* and *Aedes nigromaculis*

	Number of eggs	Initial measurement in millimeters			Final measurement in millimeters			Per- cent increase
		Mean±	S.E.m. ^a	S.D. ^b	Mean±	S.E.m	S.D.	
<i>Culex tarsalis</i>								
Width, fertile	13	0.153	0.000	0.000	0.191	0.003	0.010	19.9
Length, fertile	28	0.505	0.005	0.026	0.680	0.006	0.032	16.9
Length, infertile	28	0.556	0.005	0.025	0.713	0.008	0.039	21.7
Length in oil	17	0.527	0.003	0.015	0.585	0.009	0.039	9.9
Control	14	0.526	0.004	0.014	0.626	0.007	0.026	16.0
<i>Aedes nigromaculis</i>								
Length, fertile	8,18 ^c	0.586	0.008	0.022	0.703	0.004	0.016	16.4
Length, infertile	19,28 ^c	0.578	0.004	0.019	0.719	0.002	0.013	19.3

^a Standard error of the mean.

^b Standard deviation of the frequency distribution.

^c All figures were not available for analyses of initial measurements.

with normal eggs from the previously described test showed that they differed significantly in length even though their proportionate increases in length were the same. This demonstrates the desirability of using the same raft for test and control eggs.

Fertile *A. nigromaculis* eggs incubated at 90° F. lengthened very rapidly at first, reaching their maximum length between 15 and 21 hours after oviposition (Figure 3). After this time there was no detectable change in size. At this temperature *A. nigromaculis* eggs were capable of

this assumption. Downs (1951) demonstrated that hypertonic solutions interfered with lengthening of *Anopheles* eggs. Gander (1951) found that *Aedes aegypti* (Linnaeus) eggs lengthened less when kept on a dry surface in a saturated atmosphere than when they were on a damp surface. Gander's work with *A. aegypti*, as well as the present work with *C. tarsalis*, showed that eggs placed in mineral oil did not lengthen as much as eggs exposed to water. The increase in length that did occur was probably due to water trapped in the exochorion.

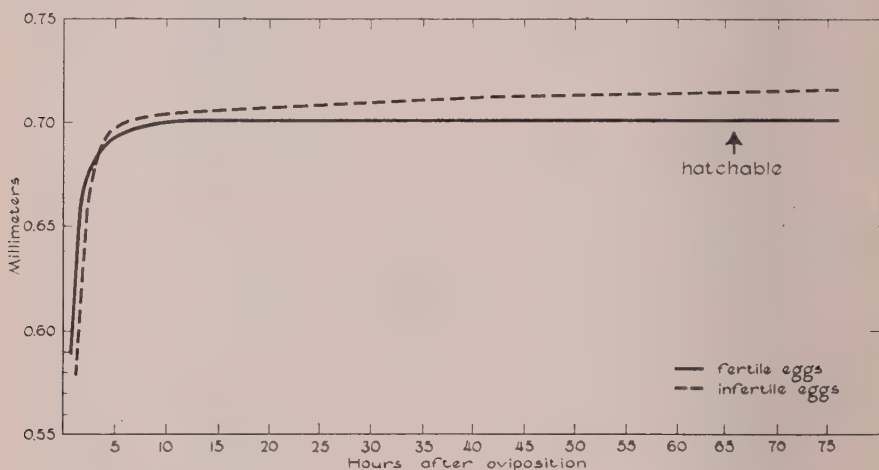


FIG. 3.—Change in length of *Aedes nigromaculis* eggs after oviposition (90° F.).

hatching 66 hours after they were laid. Infertile eggs also lengthened rapidly at first, but they continued to lengthen after the time when fertile eggs had reached maximum expansion. Initial lengths of fertile and infertile eggs were the same, but the final lengths of infertile eggs were significantly greater. The difference was 2.9 percent (Table 1).

DISCUSSION. Studies on increases in size, weight, and volume of arthropod eggs laid in moist environments have been reviewed by Wigglesworth (1950) and Edney (1957). The evidence implies that the changes were due to water absorption. Studies with mosquito eggs have supported

Since infertile eggs of *A. nigromaculis* and *C. tarsalis* also increased in size, water absorption is not dependent on embryonic development. Infertile eggs lengthened more than fertile ones in the same period of time and continued to lengthen thereafter.

At 90° F. fertile *A. nigromaculis* eggs reached their maximum size within 21 hours after oviposition; actually the lengthening was practically complete at 6 hours. *C. tarsalis* eggs continued to lengthen until they hatched. These patterns of expansion can be related to the oviposition sites of each species. *C. tarsalis* eggs are laid on a water surface where water is continually available to developing eggs. *A.*

nigromaculis eggs are laid on drying soil where free water is available for only a short time. Beckel (1955 a, b, 1958), Telford (1957), and Judson and Rosay (unpublished) have shown that fertile *Aedes* eggs become impermeable to water within a day after being laid. This is coincident with the appearance of an embryonic membrane which appears to be the most important water-proofing layer. After completing embryonic development, *Aedes* eggs are dormant until they are flooded and stimulated to hatch.

Downs' measurements of *Anopheles* eggs were similar to those reported in the present work, but the three species studied did not show a common pattern of lengthening.

SUMMARY. Eggs of *Culex tarsalis* and *Aedes nigromaculis* increased in size after oviposition. The rate of expansion varied directly with temperature, but the final size was independent of temperature. The expansion was not dependent on embryonic development since infertile eggs as well as fertile ones increased in size. Infertile eggs, however, expanded more than fertile eggs. *C. tarsalis* eggs exposed to free water lengthened more than eggs placed in mineral oil. This supported the assumption that expansion was due to water absorption. The eggs of the two species studied had different expansion rates which were related to their respective habitats. *C. tarsalis* eggs are laid on water, and they increase in size until they hatch. *A. nigromaculis* eggs are laid on drying soil where free water is available for only a short time. These eggs increased in size

rapidly at first, then no further change was apparent. The termination of expansion was correlated with the appearance of an embryonic membrane.

ACKNOWLEDGMENT. The author is indebted to Dr. A. Ralph Barr for the statistical analyses and for his help in preparing the manuscript, and she is grateful to Mr. Wilfred J. Iltis for the translation of Gander's paper.

References Cited

- BECKEL, W. E. 1955a. Presence of chitin in the transparent cuticle of the mosquito egg (*Aedes hexodontus*). Defense Research Board Northern Laboratory, Ft. Churchill, Manitoba, DRNL Tech. Memo No. 5/55. 3 pp.
- BECKEL, W. E. 1955b. A method for separating fertilized from nonfertilized mosquito eggs. Defense Research Northern Laboratory, Ft. Churchill, Manitoba, DRNL Tech. Memo. No. 6/55. 2 pp.
- BECKEL, W. E. 1958. Investigations of permeability, diapause, and hatching in the eggs of the mosquito *Aedes hexodontus* Dyar. Canad. J. Zool. 36:541-554.
- DOWNS, W. G. 1951. Growth changes of anopheline eggs in water and in saline solutions. J. Nat. Malar. Soc. 10:17-21.
- EDNEY, E. B. 1957. Water relations of terrestrial arthropods. Cambridge University Press, Cambridge.
- GANDER, R. 1951. Experimentelle und oekologische Untersuchungen über das Schlüpfvermögen der Larven von *Aedes aegypti* L. Rev. Suisse Zool. 58:215-278.
- JUDSON, C. L., and ROSAY, B. 1956-1958. California Department of Public Health, Bureau of Vector Control. Unpublished data.
- TELFORD, A. D. 1957. The pasture *Aedes* of central and northern California. The egg stage: gross embryology and resistance to desiccation. Ann. Ent. Soc. Amer. 50:537-543.
- WIGGLESWORTH, V. B. 1950. Principles of insect physiology. Methuen, London. Fourth ed.

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March 27-30

DETERMINATION OF MOSQUITO ATTACK RATES BY INTERVIEW OF KERN COUNTY, CALIFORNIA RESIDENTS¹

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Accurate data on the number of persons bitten by mosquitoes and the number of bites suffered by each are largely lacking. Although significant information on the public health importance of pest mosquitoes can be obtained by a house-to-house survey method (Hess and Quinby, 1956), most reports are descriptions of complications of bites requiring medical attention.

In Kern County, California, early in the summer of 1958, there was a high population of *Culex tarsalis* which was carrying western equine encephalitis virus. A survey was undertaken to learn the frequency of mosquito attack on the population of this area. The aims were to determine:

1. The frequency of mosquito attack on a representative sample of persons during the summer.
2. Whether the frequency of reported mosquito bites correlated with the mosquito population density shown in entomological surveys.
3. Whether mosquito bite histories would indicate the general pest level of mosquitoes, and differences in risk of mosquito bites of different parts of the population.
4. The possible values and limitations of this type of interview when conducted by a public health nursing staff.

The area surveyed was urban and suburban Bakersfield and the surrounding rural agricultural area. Peripheral mountainous and desert areas of the county were not included. In the survey area the distribution of the 200,000 residents by place of residence according to the 1950 census, was 51 percent urban and 49 percent rural.

METHODS. The public health nursing staff of the Kern County Health Department cooperated in the study. Nurses who were to work in Bakersfield and in rural areas were given a "mosquito bite history form" to be completed by them during home visits or child health conferences.

The mosquito bite history form included spaces for the following information to be filled in: name, age and sex of person interviewed, name of head of household, and relationship to person interviewed; statements on when and where person was bitten, and estimated number of bites in last 24 hours; statement of time of biting in relation to sundown, and whether indoors or out; whether or not repellants or aerosol bombs were used, and whether there was adequate screening.

Nursing notes included estimated number of bites seen, and their distribution on the body; and incidence of infected bites and other complications. The nurses obtained this information as a part of their routine home and clinic visits between June 20 and September 12, 1958.

RESULTS. Information was obtained for 242 households on a total of 502 persons—201 males and 301 females. Eighty-five percent of the interviews took place at home and 15 percent at child health conferences.

Three hundred sixteen persons (63 percent) said they were bitten. There was

¹ These studies were supported in part by a research grant from the National Institute of Allergy and Infectious Disease, N.I.H., U.S.P.H.S. The research reported represents a cooperative project between the Encephalitis Section, Communicable Disease Center, U.S.P.H.S.; the Bureau of Vector Control, California State Department of Public Health; the Kern County Health Department; and the School of Public Health, University of California.

TABLE 1.—Age and sex distributions of 502 persons surveyed regarding history of mosquito bites during the summer, Kern County, 1958

Age group	Males			Females			Both sexes		
	No. surveyed	No. bitten	Percent bitten	No. surveyed	No. bitten	Percent bitten	No. surveyed	No. bitten	Percent bitten
0-5 months	8	3	38	10	8	80	18	11	61
6-11 months	11	9	82	18	14	78	29	23	79
1-4 years	67	55	82	71	60	85	138	115	83
Subtotal 0-4 years	86	67	78	99	82	83	185	149	81
5-9 years	48	35	73	36	23	64	84	58	69
10-19 years	15	6	40	43	22	51	58	28	48
20+ years	50	20	40	120	59	49	170	79	46
Age unknown	2	1	50	3	1	33	5	2	40
All ages	201	129	64	301	187	62	502	316	63

TABLE 2.—Age distribution of 305* persons bitten during the summer showing whether or not bitten during the last 24 hours, Kern County, 1958

Age group	No. surveyed	No. bitten	Percent bitten
0-5 months	11	9	82
6-11 months	23	16	70
1-4 years	110	64	58
Subtotal 0-4 years	144	89	62
5-9 years	55	15	27
10-19 years	27	7	26
20+ years	77	26	34
Age unknown	2	0	0
All ages	305*	137	45

* Eleven persons whose history of bites within 24 hours was unknown have been deleted from the table.

a tendency for the percent of persons reporting being bitten to decrease with increasing age, from 81 percent in age groups below 5 years to 47 percent in persons over 20 years of age (Table 1). Males and females reported similar proportions with mosquito bites for each age group, and for all ages combined the proportion positive was 64 percent for males and 62 percent for females (Table 1). The age differential was also seen when the group of 316 persons who were bitten during the summer was subdivided on the basis of age and the history of bites during the last 24 hours or during the summer (Table 2). Of the 24-hour group, 65 percent were below the age of 5 years; this was higher than the age distribution of those bitten during the entire summer, in which the age group below 5 years constituted only 47 percent.

Significantly more rural residents than urban residents were bitten, and again more younger persons (Table 3).

The monthly distribution of interviews is presented in Table 4. Although fewer persons were interviewed in succeeding months, the percentage of persons bitten increased toward the end of the summer in both rural and urban residents. In the first months the percentage of rural persons bitten was higher and the percentage continued to increase throughout the summer. The attack rates reported for the 24 hours preceding the interview had an irregular pattern, being highest in urban residents in June and August and highest in August in rural residents (Table 5).

Of the 137 persons with a history of bites in the past 24 hours, 124 estimated the number of bites (Table 6). The range was from 1 to over 30 bites, most had less than 5 bites. There were no significant differences in the number of bites in different age groups.

Nurses checked validity of information by indicating whether or not they saw evidence of bites and the number of bites. Nurses examined 126 of the 137 persons with a history of bites in the past 24 hours and confirmed the report of 119. The number of bites of 108 persons was estimated by informants and nurses and a significant correlation was found between the two estimates. The group not bitten during the last 24 hours but bitten sometime during the summer was not asked to estimate the number of bites received. Nurses examined 149 persons in this group and saw evidence of bites in 62. The distribution by age and range in number of bites was almost identical to that in Table 6.

The bodily distribution of bites was reported for 172 persons. In most instances more than one area was involved—the head and one or more other areas most often (37 percent). In 65 persons only one body area was affected: legs 27 (41 percent); arms 20 (31 percent); head 11 (17 percent); body 7 (11 percent). Complications of bites, probably secondary infections, were reported for 26 out of the 316 persons bitten. It was not known if

TABLE 3.—Urban-rural differences by age* in the bitten and not bitten groups, Kern County, 1958

Age group	Urban			Rural		
	No. surveyed	No. bitten	Percent bitten	No. surveyed	No. bitten	Percent bitten
0-4 years	121	89	74	63	59	94
5+ years	256	118	46	52	43	83
All ages	377	207	55	115	102	89

* 5 persons with age unknown and 5 persons with residence unknown are deleted from this table.

TABLE 4.—Distribution by month and place of residence * of 502 persons surveyed regarding history of mosquito bites during the summer, Kern County, 1958

Month of Interview	Urban			Rural			All areas		
	No. surveyed	No. bitten	Percent bitten	No. surveyed	No. bitten	Percent bitten	No. surveyed	No. bitten	Percent bitten
June	201	110	55	57	46	81	258	156	60
July	163	85	52	15	13	87	178	98	55
August	15	12	80	16	16	100	31	28	90
September	2	1	50	28	28	100	30	29	97
All months	381	208	55	116	103	89	497 *	311	63

* Place of residence was undetermined for 2 in June and 3 in July.

TABLE 5.—History of mosquito bite during the last 24 hours for 486 persons distributed by month and place of residence,* Kern County, 1958

Month of Interview	Urban			Rural			All areas		
	No. surveyed	No. bitten	Percent bitten	No. surveyed	No. bitten	Percent bitten	No. surveyed	No. bitten	Percent bitten
June	199	47	24	55	26	47	254	73	29
July	160	26	16	15	7	47	175	33	19
August	15	5	33	15	13	87	30	18	60
September	2	0	0	25	10	40	27	10	37
All months	376	78	21	110	56	51	486 *	134	28

* Sixteen persons for whom complete data were not available and not included in this table.

TABLE 6.—Age distribution and estimated number of mosquito bites as given by informants for 137 persons bitten during the last 24 hours, Kern County, 1958

Age	Estimated number of bites						Total	Estimate not stated	Total bitten last 24 hrs.
	1-4	5-9	10-19	20-29	30+	Some, number not stated			
0- 5 months	4	2	2			1	9		9
6-11 months	5	4	5	2			16		16
1- 4 years	35	14	5		2		56	8	64
Subtotal									
0- 4 years	44	20	12	2	2	1	81	8	89
5- 9 years	7	4			1		12	3	15
10-19 years	3	4					7		7
20+ years	12	5	2	3	1	1	24	2	26
Total	66	33	14	5	4	2	124	13 *	137

* Of this group the nurse saw evidence of bites in 6 cases.

the complications required medical attention.

Another variable considered was the individual means of protection from attack. Of those who replied to the inquiry, 19 percent used repellents and aerosol sprays. Comparison of the use of repellents and aerosol sprays between the bitten and unbitten group revealed that more of the bitten group than the unbitten group used these measures. The same was found when the data were analyzed according to households instead of to persons. Persons probably used protective measures after they had been bitten rather than before.

In 54 percent of the homes screening was classified as adequate, but this judgment did not differentiate the groups reporting positive and negative histories of mosquito bites. For 105 persons who replied whether they were bitten indoors, outdoors, or both: 19 persons were bitten only indoors, 56 only outdoors, and 30 in both. Of those who were bitten only indoors, adequate screening was reported by 28 percent. For those bitten only outdoors, 80 percent reported adequate screening.

The time of day bitten was determined for only 98 of the 316 who were bitten. Eleven persons said they were bitten before sundown, 76 after sundown, and 11 both before and after.

The geographical location where bitten was: at or around home, 229 (72 percent); recreational areas, 27 (9 percent); visits away from home, 10 (3 percent); at work, 5 (1 percent); and not specified, 43 (14 percent). Most of the people were bitten at home outdoors in the evening.

DISCUSSION. Information on the frequency and extent of mosquito bites among residents of a given area may be obtained by the methods reported here. The method has certain limitations insofar as epidemiology is concerned. The number of interviews each month was unequal and the sample interviewed probably did not represent the total population of the area for it was assumed that nurses would see urban and rural population groups who had a higher risk of exposure to mosquitoes than

the general population. Further, the bias introduced because of selection by the nurse, of who was to be interviewed, how many and when, could not be eliminated, largely because of limited staff and resources. As a usual thing, husbands were not at home at the time of the nurse's visits and the histories for them were not as reliable as those relating to the informants and children. This also resulted in a larger proportion of females than males in the study, with the interviews conducted in child health conferences further increasing this preponderance. Some effort was made in the questionnaire to provide verification by the nurse of the information given. There was close agreement between the informant's and the nurse's estimate of the number of bites.

Mosquito activity was measured during the summer by routine entomological means and the adult mosquito population decreased markedly in midsummer in the urban area because surface water decreased and control measures by the Kern Mosquito Abatement District were intensive. The mosquito population decreased less in the rural areas. These changes were reflected in the accounts of mosquito bites. The principal causes of urban-rural differences were the larger number of mosquitoes per person in the rural areas and factors such as occupation, housing, and self-protection affecting exposure.

The highest mosquito attack rates were in children under 5 years of age. Fewer infants below 6 months of age than the older children were bitten possibly because it would be easier for mothers to protect infants from attack.

It is open to question whether all the reported bites were mosquito bites. Trombiculid mites have been found in this area and could have inflicted some of the bites. Thirty-four percent of the 316 persons bitten during the summer and 43 percent of the bitten in the past 24-hour group said that they saw mosquitoes biting. The geographical location of the person when he was bitten, portion of the body, and the time of the day make it seem

probable that the bites were by mosquitoes rather than chigger mites or other blood-sucking arthropods. Finally, we may assume that both the informants and nurses had a fair degree of familiarity with the local arthropods and their characteristics. *Culex tarsalis* was the predominant mosquito in the area during most of the summer and readily bites man. The pattern of attack on the population clearly incriminates this mosquito as being involved in a high proportion of the cases recorded.

Of the 17 serologically confirmed cases of arthropod-borne encephalitis which were reported from Kern County during the summer, four were members of households included in the survey; two 3-month-old males and a 7-year-old male had western equine encephalitis, and a forty-three-year-old woman had St. Louis encephalitis. The households of the three western equine encephalitis patients were visited by the nurse after the onset of illness, for the completion of an epidemiologic history form. The mother of one of the 3-month-old children with western equine encephalitis told the nurse that both of her children (the diseased and a healthy sibling) had been bitten. The seven-year-old also was reported to have been bitten. The mother of the other infant patient said he had not been bitten. The visit to the home of the St. Louis encephalitis patient took place 11 days prior to the onset of the disease; although mosquitoes had been seen by the patient and she reported that her five children had been bitten, she denied having had any bites during the summer. Three of these four families reported using DDT

spray and all reported having "adequate screening" on the windows and doors of their homes.

The value of future surveys would be increased by the including of more detailed questions in the questionnaire, obtaining more complete information, larger samples, and an equal sampling of rural and urban residents distributed evenly throughout the summer.

SUMMARY. During the summer of 1958 the nursing staff of the Kern County Health Department filled out questionnaires on the history of mosquito bites of residents of the area during their routine home and clinic visits. The answers provided data on the frequency and extent of mosquito bites experienced by 502 persons (242 households) under their ordinary living conditions.

Significantly more rural than urban residents were bitten. The percentage of persons bitten increased through the summer. The number of mosquito bites received during the 24 hours immediately preceding the interview was estimated by the informant and checked by the nurse and numbers given by these two were similar. More younger persons than adults were bitten and they had more bites each. Most persons were bitten outdoors in the evening. *Culex tarsalis*, known to be prevalent in the area, usually feeds in the evening.

References Cited

- HESS, A. D. and QUINBY, G. E. 1956. A survey of the public health importance of pest mosquitoes in the Milk River Valley, Montana. Mosq. News 16(4):266-268.

Join the March March on Boston

AMCA

March 27-30

OPERATIONAL AND SCIENTIFIC NOTES

MASS PRODUCTION OF MOSQUITO LARVAE.—That tropical-fish fanciers have utilized mosquito larvae as food for their fish is well known. Many of them spend considerable time in the field during warm weather collecting the larvae in quantity so as to give their fish a "real treat." In fact, the excess collected is put into small closed containers, frozen and stored for use at a later date when the living ones are no longer available. For the last two years the author has been producing *Culex pipiens* and *Culex restuans* in metal tanks in such quantities as to make mass production and wholesale distribution to pet shops profitable.

The production of larvae is relatively simple but the problem is to produce them in extremely large numbers in water free of floating debris so that only pure larvae are removed by means of a hand net. All of the manures and other media used added too much unwanted material to the tanks and consequently to the containers of larvae.

The following method eventually proved most satisfactory. About twenty metal tanks (cattle watering-troughs) were placed on the ground and filled with spring water from a garden hose. The tanks measured approximately 3 x 6 x 2 feet. The water was kept at a depth of about 1½ feet. Ears of dried corn were then added to the water at the rate of four per tank and allowed to decay. Usually the kernels remained on the ear which either sank or floated. A bacterial scum formed on the surface of the water and was, after three weeks in June, covered with the rafts of culicine eggs. Following this, larvae (and pupae) were netted every three days through the month of September. Each tank yielded about sixteen ounces (bulk, not weight) per week which were put into plastic bags, sealed, and frozen, for distribution to pet shops.

Several points of interest, which will sound familiar to mosquito men, have been noted. A shallow tank will produce more larvae than a deep one. Several small tanks will produce more larvae than one large one since the production is mostly confined to the edges. The proportions of the various species changed as the conditions within the tanks changed. Obviously other species of mosquitoes appeared at intervals. For example, *Culex pipiens* was most abundant when the rainfall was slight and there was a heavy growth of bacteria. *Culex restuans* increased in proportion whenever the water became diluted by heavy rainfalls. The last observation was that there was practically no biting by adults in the vicinity. —Charles O. Masters, Walhonding, Ohio.

A VERSATILE MOSQUITO REARING CAGE.—There are many occasions where it is helpful to rear larvae to obtain the fourth instar larval skin as well as the adult mosquito for study purposes. Mr. Thomas W. Bordner, foreman, designed and constructed to comply with my requirements a relatively simple rearing cage which has been in successful use this past year at the Toledo

Area Sanitary District laboratory. Mr. Robert H. Coker, equipment operator, made the drawings and helped compose the following directions. May they prove useful to you. (See Figures)

For the base of the rearing cage any soft wood is suitable. We used white pine measuring ¾" thick, 3½" wide and 12" long. Measure in from either end 1¼" and 1¾" from either side. This will give the center of the 3" hole to be drilled at this point for a depth of ¼". Use a wood chisel to clean out excess wood and make a smooth finish to the bottom of the recess. If the drill penetrates the base, plug the hole with plastic wood or glue. (A pull-out tray can be fitted under the recess to facilitate easy removal of adult mosquitoes, but we still have this to do!) Trim off ¾" from both sides of the base, stopping 3½" from the end with the recessed hole.

The 'stop' or movable brake is made of two ¾" x 1½" x 1½" blocks for brakes with another block ¾" x 1½" x 2" for spacer. Drill a ¼" hole in each brake 1" from the bottom edge and ¾" from the side edge. Drill a ¼" hole through the spacer block using one brake for guide. Make sure the edges are flush. With a ¼" x 4" carriage bolt and wing nut secure this 'stop' device to the handle of the base.

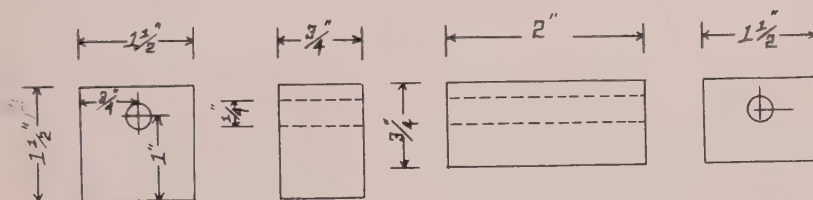
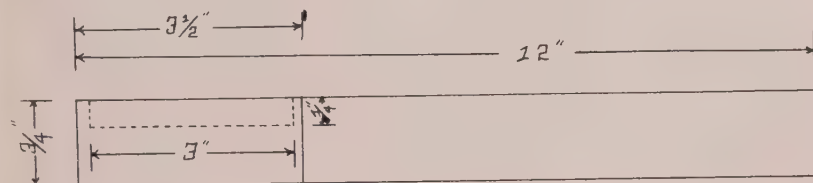
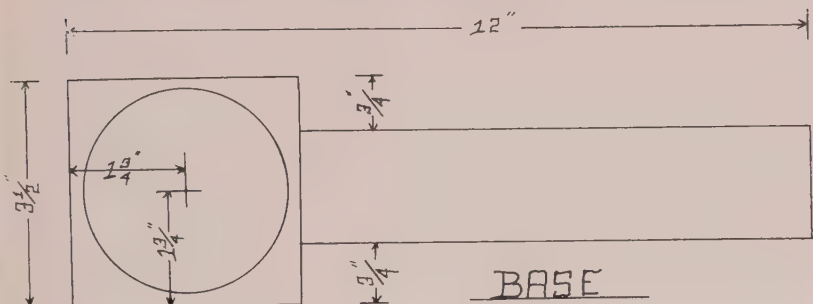
Take a piece of wood 3½" x 3½" x ¾" and cut diagonally, making a 45° angle brace to be mounted on the base with a 3½" side down to hold the cone in place.

The cage is made of #16 mesh screen 9" x 9". Roll two sides together and secure. Cut a circle 3" in diameter and secure to one end of this cylindrical cage. Approximately half way up one side cut a 1" hole. Make a cone from #16 mesh screen 4¼" x 8½" with a diameter of 5" at the base and 1" at the top. Place the cylindrical cage in the 3" diameter recess of the base and slip the cone's small end in the 1" hole in its side. The cone should rest on the base block. Fit the angle brace under the cone, mark its position and secure the angle brace to the base and the cone to the angle brace.

In use, any medium sized bottle can be placed in the cone and held firmly in position with the adjustable 'stop.' The slanting position of the bottle reduces housekeeping chores by permitting evaporation of water without hindrance to larval or pupal life and at the same time makes available a maximum of water surface and adult resting surface. It has been our experience that adults will proceed up the cone into the cylindrical cage where they can be held indefinitely with little possibility of drowning. Both the bottle and cylindrical cage can be removed at will to secure larval skins or adult specimens.

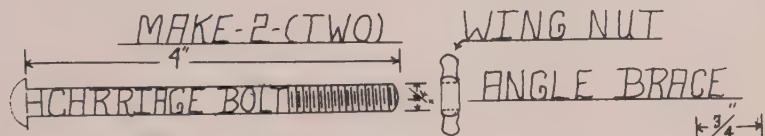
We have in satisfactory use this cage and one of half these dimensions. Of course, it could be made on a much larger scale and adapted for use other than mosquito rearing.—Elizabeth K. Lennox, TASD Technician.

MOSQUITO REARING CAGE



STOPS

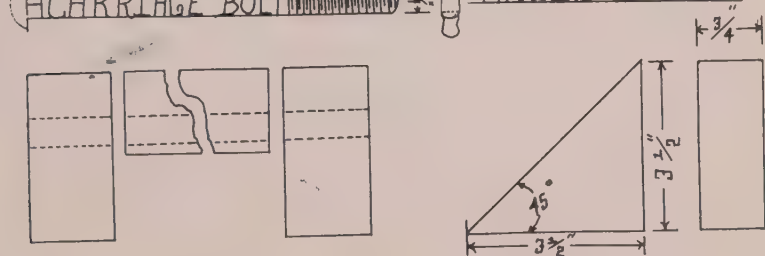
SPACER



MAKE-2-(TWO)

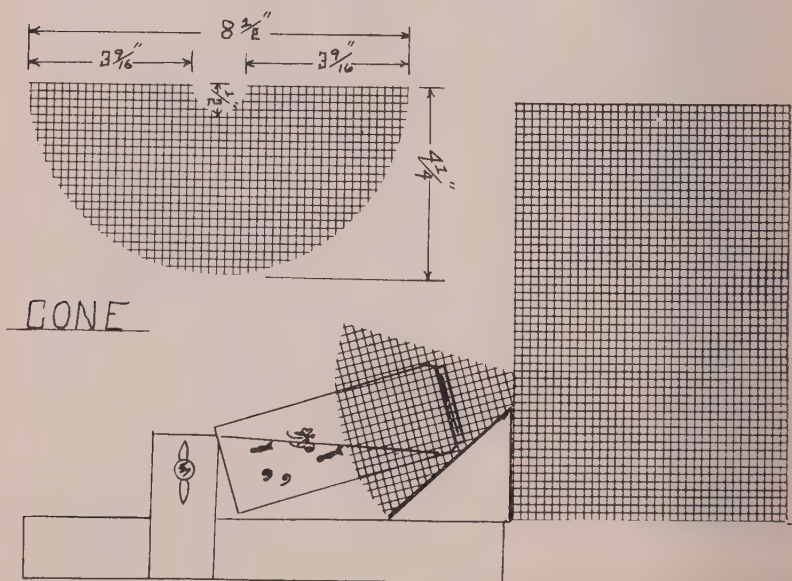
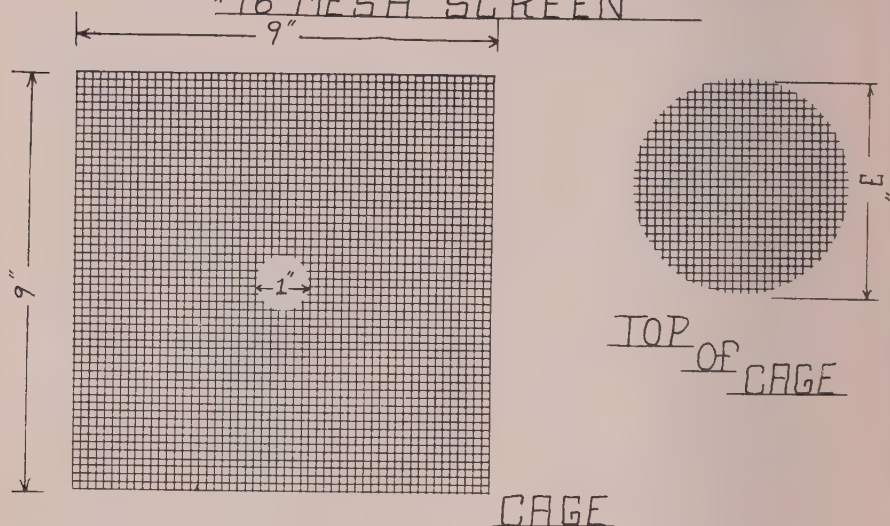
WING NUT

ANGLE BRACE



CAGE AND TOP MADE FROM

#16 MESH SCREEN



Aedes vexans and *Culex salinarius* LIGHT TRAP COLLECTIONS AT FIVE ELEVATIONS.—A study was conducted for two seasons in a wooded area at the U. S. Army Chemical Center, Maryland, to determine if the numbers of mosquitoes collected in light traps varied significantly between 5-foot levels within a 20-foot elevation. MacCreary (1941) had studied the difference in mosquito collections taken in light traps operated at 4 to 5 feet and at 80 and 103 feet aboveground.

Five New Jersey mosquito light traps, each equipped with a 40-watt frosted light bulb, were operated between 6 p.m. and 6 a.m. from May through November during 1957 and from June to August during 1958. The traps, suspended from a metal pipe that extended between two trees, were operated with their opening at 1.5, 5, 10, 15 and 20 feet aboveground. To minimize any errors that might be introduced by trap position and individual trap efficiency, a daily schedule of changing trap elevations was followed. Each trap was operated for one night at each of the elevations during each 5-day period, and only one trap was operated at each elevation on any given night.

A total of 17,691 mosquitoes, representing 22 species, were collected. However only *Aedes vexans* and *Culex salinarius* were collected in significant numbers during either year. The average number of both male and female *Aedes vexans* collected per trap night was approximately the same each year. However, the average number of both male and female *Culex salinarius* taken per trap night in 1958 was approximately 8 times greater than the average number taken in 1957.

During both years, more *Culex salinarius* males and females were taken at the 20-foot level than at any of the lower levels. In the males this difference was significant to the one-tenth-percent level during both years. In the females this difference was significant to the one-percent level in 1957 and to the one-tenth-percent level in 1958. *Aedes vexans* males were also taken in the greatest numbers at 20 feet during both years. This difference was significant to the five-percent level in 1957 and to the one-tenth-percent level in 1958. *Aedes vexans* females were taken in the greatest numbers at 1.5 feet in 1957 and at 20 feet in 1958. In each year's collection this difference was significant to the one-tenth-percent level.

The authors express their appreciation to Major Hilton H. Earle, Jr., U. S. Army Environmental Health Laboratory, Army Chemical Center, Maryland, for the statistical analysis of the data contained in this paper.

References Cited

MACCREARY, D., 1941. Comparative density of mosquitoes at ground level and at an elevation of approximately one hundred feet. J. Econ. Ent., 34:174-179.

TECHNOLOGY BRANCH; COMMUNICABLE DISEASE CENTER; PUBLIC HEALTH SERVICE; DEPARTMENT OF HEALTH, EDUCATION AND WELFARE. 1956. Summary of Investigations No. 10, p. 193. —Theodore E. Blakeslee, Richard Axtell and Laurence Johnston, Entomology Division, U. S. Army Environmental Health Laboratory, Army Chemical Center, Maryland.

TABLE 1.—Summary of total trap captures by elevation

Year	Species	Sex	Elevation (Feet)					Least significant difference*
			1.5	5	10	15	20	
1957	<i>Aedes vexans</i>	Female	1339	469	306	379	643	92
1958	<i>Aedes vexans</i>	Female	322	249	187	246	538	63
1957	<i>Aedes vexans</i>	Male	60	91	92	103	204	27
1958	<i>Aedes vexans</i>	Male	25	12	24	36	69	10
1957	<i>Culex salinarius</i>	Female	143	218	209	205	302	23
1958	<i>Culex salinarius</i>	Female	266	529	756	1018	1636	155
1957	<i>Culex salinarius</i>	Male	18	36	39	31	82	8
1958	<i>Culex salinarius</i>	Male	29	34	99	207	397	34

* P = .01.

EDITORIAL

EXPANDING INTERESTS OF THE AMERICAN MOSQUITO
CONTROL ASSOCIATION

A. D. HESS *

The bylaws of our American Mosquito Control Association provide for a broad field of interest of our members. Section 1 of Article II states that the purpose of the Association is "to promote research on and control of mosquitoes and related subjects in the broadest sense. . . ." The following brief summary of the results of a recent survey indicate that the interests of our members fit this broad pattern.

Members of the Association can roughly be divided into those primarily concerned with the technical aspects and those primarily concerned with the practical or operational aspects of mosquito control, though there is, of course, some overlapping. As an indication of the interests of the technical group, a check was made of 165 members of AMCA who are listed in Volume II (Biological Sciences) of the 9th edition of *American Men of Science*. Two-thirds of these were trained as entomologists, 10 percent having specialized in medical entomology, and 6 percent were M.D.'s. It can be assumed from the fact that they are members of AMCA that all of these individuals have some interest in mosquitoes; however, only 10 percent listed mosquitoes as their primary field of interest. In contrast, 43 percent indicated a primary interest in arthropods of public health importance (including medical entomology) as defined above. These outnumbered those with primary interests in all other fields of entomology combined (37 percent). This is strong evidence that a major segment of the technical members of our Association are interested in arthropod vectors in general rather than merely in mosquitoes.

In order to obtain an idea of the breadth of interest of those actually engaged in

mosquito control operations, a questionnaire was sent out to 161 mosquito abatement agencies located throughout the United States. Fifty-one replies were received from 13 states as follows: California 15; Florida 7; Illinois 4; Massachusetts 2; Minnesota 1; New Jersey 6; North Dakota 2; Pennsylvania 2; Oregon 4; South Carolina 1; Texas 2; Utah 3; and Washington 2. It was surprising to find that over half of these (55 percent) were already engaged in other vector control activities in addition to mosquito control. About three-fourths of this activity was concerned with fly control, including general sanitation and refuse disposal. Other activities included the control of biting Diptera (*Culicoides*, *Leptoconops*, and Simuliidae); non-biting Diptera (midges, phantom midges, ephydriids, etc.); ticks, mites, and chiggers; spiders, earwigs; household pests; rodents; and weeds.

Eighty-one percent of those replying stated that mosquito abatement agencies should be engaged in other vector control activities in addition to mosquito control. Two-thirds of these indicated that they should do fly control. Biting and non-biting flies; fleas; ticks, mites, and chiggers; household pests and "all arthropods of public health importance" were among the other vectors which various mosquito control agencies felt should be included. Of the minority which indicated they should not take on additional vector control activities, several gave as their reason the lack of adequate funds and personnel. Some individuals stated that they should be prepared to carry out any additional vector control which the public demanded and would support financially.

We believe that this broad field of interest of both the technical and operational members of our Association is a healthy one and should be encouraged.

* From the Communicable Disease Center, Bureau of State Services, Public Health Service, U. S. Department of Health, Education, and Welfare, Greeley, Colorado.

ASSOCIATION NEWS

SIXTEENTH ANNUAL MEETING

of the

AMERICAN MOSQUITO CONTROL ASSOCIATION

Meeting jointly with the Northeastern Mosquito Control Association

Boston, Massachusetts

Hotel Somerset

March 27, 28, 29 and 30, 1960

PROGRAM NOTES

Ample time is being allocated for presentation of submitted papers. The deadline for submission of titles is February 1, 1960. Titles should be sent to the Chairman of the Program Committee.

Trustees, Commissioners, and Directors of Mosquito Control organizations will have a conference room available for informal discussions of problems of mutual interest.

Members are reminded that there will be panel discussions featuring Migration and Dispersion of Adult Mosquitoes, Effects on Man and Animals of Insecticide Residues, Insecticide Resistance, Eastern Equine Encephalomyelitis, and Malaria Control Methods.

Every effort is being made to promote a most worthwhile session devoted to practical operations problems.

Miss Helen Sollers will give an illustrated talk on "The Soviet Union and other European Countries as Viewed by a Mosquito Worker."

Participation in the meeting by all members is invited.

D. M. JOBBINS, *Vice Chairman*
Program Committee
Rutgers University
New Brunswick, New Jersey

WILLIAM E. BICKLEY, *Chairman*
Program Committee
University of Maryland
College Park, Maryland

REPORT OF THE NOMINATING COMMITTEE OF THE AMERICAN MOSQUITO CONTROL ASSOCIATION, INC., FOR 1959.

In accordance with Article 7, *Nomination of Officers*, Section 1, *Duties of the Nominating Committee* as described in the Constitution and Bylaws ("The Nominating Committee shall submit at the next annual meeting a report on nominations to the membership of the Association at a preliminary business meeting and shall submit at least one nomination for each office to be filled by an election at that annual meeting"), Your nominating committee presents the following report for your consideration:

For President—D. M. Jobbins (New Jersey)

For President-Elect—Wm. E. Bickley (Maryland)

For Vice President—

1. P. Bruce Brockway, Jr. (Ohio)
2. W. J. Buchanan (Illinois)
3. A. W. Buzicky (Minnesota)
4. A. F. Geib (California)
5. Don W. Micks (Texas)

For Recording Secretary—

1. W. J. Buchanan (Illinois)
2. A. F. Geib (California)
3. A. W. Morrill, Jr. (California)
4. Ernestine Thurman (Maryland)

For Regional Directors—

SOUTH ATLANTIC REGION—*

1. J. A. Mulrennan (Florida)
2. K. D. Quarterman (Georgia)

NORTHWEST CENTRAL REGION—

1. Jay E. Graham (Utah)
2. Wm. F. Rapp, Jr. (Nebraska)
3. Don M. Rees (Utah)

SOUTHWEST CENTRAL REGION—

1. Osmond P. Breland (Texas)
2. Frank J. Von Zuben (Texas)

NORTH PACIFIC REGION—

1. W. C. Frohne (Alaska)
2. C. M. Gjullin (Oregon)
3. L. S. Miller (Oregon)

MEXICO, CENTRAL AND SOUTH AMERICA REGION—**

1. Pedro Galindo (Panama)
2. Luis Vargas (Mexico)

Respectfully submitted,

Robert L. Armstrong (Massachusetts), A. W. A. Brown (Canada), W. J. Buchanan (Illinois), Helen Louise Durkee (California), Richard B. Eads (Texas), J. G. Foyle (Texas), Jay E. Graham (Utah), Austin W. Morrill, Jr. (California), Patrick Y. Nakagawa (Hawaii), Richard F. Peters (California), Don J. Pletsch (Mexico), Kenneth D. Quarterman (Georgia), A. B. Ritter (Louisiana), H. E. Schoof (Georgia), Harry H. Stage (Oregon), Robert L. Vannote (New Jersey), John M. Hirst MSC U. S. Navy—Chairman.

* Note: Captain Kenneth L. Knight, MSC, USN, was nominated for this office but Dr. Knight is presently located in North Carolina, which is in the Southeast Central Region.

** Note: Don J. Pletsch (Mexico) was nominated for this office but he has requested that his name be withheld.

NEWS AND NOTES

AUSTIN W. MORRILL, JR.

WHEN *News and Notes* WAS BEING PREPARED FOR LAST ISSUE OUR EYE FELL ON A NEWS ITEM FROM FORMOSA WHICH WE THOUGHT OUGHT TO BE RECORDED IN OUR COLUMNS. Unfortunately, limitations of space prevented it, but we still think it's of interest, so here goes: In Taipeh the Buddhist priests have been conducting a prayer session for the souls of all the mosquitoes and other living things which have been sacrificed in the course of American experiments in control, by the U. S. Navy Preventive Medicine Unit No. 2. The prayers were reported to be lengthy,—a compliment to the effectiveness of our control, "numberswise," as the Americans say.

AND SPEAKING OF THE NAVY . . . ENSIGN JOHN A. MULRENNAN, JR., USNR, reported on board at the U. S. Navy Disease Vector Control Center, Naval Air Station, Alameda, California, in early August, and mighty happy we all are to have him, too. He arrived fresh from an indoctrination course at Newport, R. I., and freshly married, too, and if he was disappointed not to be assigned to the Center at NAS Jacksonville, Florida, near his famous and much-respected Dad, he has been polite enough to conceal it. What with the California Bureau of Vector Control and all these Mosquito Abatement Districts around him, if he had any idea of getting *away* from mosquitoes, he might just as well abandon it! Anyway, as we said when we first heard he was now in the Navy . . . Welcome Aboard!

ANOTHER NAVY MAN, OUR EX-PREX "Mo" FIRST IS JUST ABOUT AS HARD TO KEEP TRACK OF AS UNCLE HARRY STAGE, but we managed to catch hold of his coat-tails momentarily as he went with his family through San Francisco en route to his new station. After a short visit to old home towns, he reported in at the U. S. Naval Medical School, National Naval Medical Center, Bethesda, Maryland, which is right across the road from the National Institutes of Health, as many of you know, and right in the hub of things entomological and culicidological. "Mo" is busily whipping up activity in the Nominating Committee, and very efficiently, we might add, with the expectation that a comprehensive slate representing a wide sampling of choices will be presented in the issue of *Mosquito News* appearing just before the 1960 meeting.

AND IN THE NO-ONE-EVER-TELLS-US-ANYTHING DEPARTMENT we had word via "Mo" that STEPHEN M. K. HU had slipped through San Francisco a while back on a brief visit to his children here on the mainland. Dr. and Mrs. Hu, after a stop in Honolulu to see their old haunts and friends (these are not the same and

no old joke is intended, so watch it, boy), were on this continent for a two-week stay and then returned to the Naval Medical Research Unit No. 2, on Formosa.

SPEAKING OF OUR CONSTANT PLEAS FOR PEOPLE TO SEND US NEWS AND NOTES, we *do* appreciate the time you-all take from your busy schedules to send us these items. We are deeply grateful and we most devoutly hope that our failure to acknowledge these gems, other than to run them in this column, will not deter any of our good, kind, generous correspondents from making further contributions. WE KNOW that the way to get letters is to write them, but . . . Anyway, please don't think your letters have just dropped in a well. And do keep us on your list!!

ONE DEVOTED CORRESPONDENT IS BILL BICKLEY WHO SPOTTED THE FOLLOWING DISPATCH IN THE WASHINGTON POST:

N. J. Mosquitoes Win

Trenton, N. J., Sept. 1 (AP)—Okay, you pesky New Jersey mosquitoes, they're throwing in the towel. You win.

State Sen. Charles W. Sandman, bowing to the inevitable, yesterday introduced a bill to change the title of County Mosquito Extermination Commissions to Mosquito Control Commissions.

End of quote. Never mind, New Jersey, we all have problems!

SPEAKING OF NEWSPAPERS, THE WRITE-UP LES BRUMBAUGH GOT IN THE STOCKTON (CALIF.) RECORD, which we reported here last time, and several he has had since, all sounded so good, we decided to visit him ourselves. Les has what is undoubtedly the most elaborate and well-equipped set of offices, laboratories and shops in our entire experience, military or otherwise. His program, coming up from scratch in four short years, is a testament to the value of having the right tools to work with and we were also impressed with the completeness of his records. He has a field data sheet for just about everything you usually wish later you'd kept a record of, and this really awed us; because in the military, of course, you have to have almost-perfect records, lest some Big Brass come around some fine day and demand to know what in Tunket mosquito abatement is *for* and why have it when there aren't any mosquitoes? Les feels it's equally important for waving in front of political Brass and his trustees have shown an enthusiastic appreciation. Incidentally, while county taxes rose in his area this year, Les cannily reduced his bite (a *little*) and this won him no really dedicated critics. He has a number of pamphlets and things, too, and samples of these are all available, if you are interested.

ROLLIE DORER'S AND THE VIRGINIA MOSQUITO CONTROL ASSOCIATION'S fine little news-sheet, *The Skeeter*, announces in its July-and-August issue that Mr. John Lamb, entomologist of the Virginia Bureau of Insect and Rodent Control, is commencing a study of sewage oxidation ponds in their relation to mosquito breeding. The method of oxidizing and digesting sewage in ponds has become more and more widely adopted and with its use has come the inevitable question of its effect on pest and vector populations. The results of this study will be of great interest to many of us and we shall await their publication with impatience.

ACCORDING TO OUR SAME DEPENDABLE LITTLE SOURCE, the new-style revival of paris green larvicide, which was developed in Florida and on which CLYDE FEHN of the USPHS Savannah lab reported at the VMCA meetings last year, is showing very promising results in Virginia and has a number of practical advantages in application. It reaches well into obstructed or overgrown water collections, can be applied when or where oil would be unsuitable, is inexpensive, long-lasting in hard-bottom situations, such as boats and tires, and is simple to apply.

DR. A. W. A. BROWN RECENTLY SENT US A ROUNDUP OF SOME OF HIS VARIED ACTIVITIES AND THEY SOUND MIGHTY INTERESTING, NOT TO SAY FASCINATING'. In late May and June, he visited Czechoslovakia, Poland, Roumania, Bulgaria and Yugoslavia as a WHO consultant and put out a mimeographed report, "WHO/Insecticides/99," available in mimeographed form from WHO, Palais des Nations, Geneva. He says that while pest control programs are mainly restricted to Hodonin and Bratislava, Czechoslovakia; to Szczecin in Poland; and to islands in the Danube in Roumania, anti-anopheline measures are still necessary and are vigorously prosecuted in Southern Roumania, Bulgaria and Yugoslavia. Public health insect control is undertaken in all these countries by the system of Sanepid units in each district. Tony also went on to Australia, where among other things he took part in a seminar on resistance, similar to one with which he assisted in Cairo in May. (We imagine this is a modest way of saying Tony taught a class in resistance! Very few of us are as comprehensively informed as Tony is.)

ANOTHER WHO'ER FROM WHOM WE HEAR ALL TOO SELDOM IS DON PLETSCHE and now we have a letter from him, too! He writes, "Things have been humming in the Mexican malaria eradication program. The third year of total spraying operational coverage will end in December, 1959, with one year of spraying operations left to go. More than 3.3 million houses are receiving intradomiciliary treatment with DDT (some with dieldrin) in the malarious area, so

there are more than 6 million house-spraying being done each year (DDT areas are being treated twice)." (That word "intradomiciliary" is just how Doctors talk; us folks say "inside the house," but don't be thrown off by that, because Don is really a do-er as most of you know.) Dr. Pletsch goes on to say, "Spraying operations are really well organized. More than 2,500 spraymen are working full time under excellent supervision. Epidemiological evaluation is assuming increasing importance and Dr. LUIS VARGAS' Office of Evaluation is of more and more importance as the 'score' starts to roll in from more than 70,000 localities. There are definitely some tough foci," he concludes, "but I'm very optimistic about attaining the eradication objective here."

ANOTHER WHO PROJECT IN MALARIA ERADICATION, as reported in the University of Minnesota's *Newsletter*, is a Malaria Pilot Project in the Sudan, headed by a Dr. A. A. Soliman, whose headquarters is in Sennar, a small town on the Blue Nile about 150 miles south of Khartoum. The principal vector is *A. gambiae*, but eight other species also prevail in the area, among which *A. funestus* has also been implicated as a vector.

ONE OF OUR OWN INTERNATIONAL TYPES HERE AT HOME IS DR. ERNESTINE THURMAN, who we thought was about as busy as she could be, what with the Good Neighbor Club and all, but she has written a delightful chapter giving an evaluation of Dr. R. E. Snodgrass' great work and a most interesting account of his life, which became part of a volume published by the Smithsonian Institution in honor of Dr. Snodgrass' 84th birthday. *Science*, in its review, took occasion to single Ernestine's chapter out for especial praise, mentioning that she found to illustrate it, a number of cartoons and nonentomological drawings by Snodgrass and closed the chapter with a very characteristic personal note by the artist. The review in *Science* is by ALAN STONE, a not-unknown AMCA'er himself.

THE CALIFORNIA MOSQUITO CONTROL ASSOCIATION'S YEAR BOOK for 1959, now available, lists among the interesting and valuable data in the several tables, the tax rates enjoyed by the several Districts. These range from .005 to .40, the lowest rates being usually, but not always, from the most metropolitan areas with the highest property evaluations. There is also a wealth of material on source reduction and insecticiding.

THE ILLINOIS MOSQUITO CONTROL ASSOCIATION CELEBRATED ITS FIFTH ANNUAL CONFERENCE this year and the program included papers on the vital question of the often-assumed conflict between the use of insecticides and the conservation of wild life, a matter on which a good deal of actual, on-the-ground observation and counting have been done in this state.

DR. FRED C. BISHOPP'S NEW ADDRESS will be E. River Drive and Edgewood Avenue, Ft. Meyers, Florida. MAJOR R. M. ALTMAN is now at the University of Maryland, College Park, studying with BILL BICKLEY (we're going to have to put the professor in uniform, the way he's handling the education of the Armed Forces for us!), and FRED MORTON is now at the Engineer Office, HQ USARCARIB, Ft. Amador, Canal Zone. MAJOR TED BLAKESLEE has left the Army Environmental Health Laboratory for the 6th U. S. Army Medical Laboratory at Ft. Baker, California, while MAJOR BOB STAPP has left the A.E.H.L. for the 5th U. S. Army Medical Laboratory at 12th and Spruce Sts. in St. Louis (2), Missouri. RUSSEL D. ANDERSON, making perhaps the best move of all, has traded beautiful (but cold in the winter) Salt Lake City for beautiful and warm Laie, Oahu, Hawaii, P.O. Box 59. We guess even a box, if it's in Hawaii, is pretty good to live in, Steig to the contrary notwithstanding.

FRANCISCO DY, OF THE WHO REGIONAL OFFICE FOR THE WESTERN PACIFIC IN MANILA, has sent us a reprint from the *Acta Medica Philippina* which concerns work he did on malaria eradication in 1956; it was a little delayed in being published by *Acta*, but is nevertheless still interesting. In it, Dr. (and also Col.) Dy tells of the need to convince people that spraying the insides of houses against a supposedly "wild" species would break the chain of transmission even if it did not eradicate the species, a problem he had had previously when we had a military malaria prevention program in the Philippines. It reminds us that this is our never-ending need in mosquito control, to convince Our Public, which often includes our potentially staunchest friends among the Medics and the Engineers, that mosquito control *does work*.

FOR WHO'S WHO THIS MONTH WE HAVE ONE OF OUR OLDEST (LONGEST, THAT IS) AND ONE OF OUR YOUNGEST MEMBERS:

JONATHAN S. GIBSON of the Newport News Shipbuilding and Dry Dock Co., Newport News, Virginia has been a member for 13 years and involved in mosquito control since 1932. This doesn't tell the whole story by a long shot, though. He was born in County Antrim, in Northern Ireland in 1901 of American parentage, grandparentage and great-grandparentage and was one of 6 brothers and 2 sisters, who now live, in addition to Northern Ireland, in Canada, Australia, Singapore, England and here. He was educated in Belfast and went to the College of Technology there, graduating as an honor student and medal winner in Naval Architecture and Sanitary Engineering, and then going on to Queens Uni-

versity to receive a degree there in Naval Architecture also. He arrived in the United States in 1927 and has been in Newport News ever since. It didn't take him long to become interested in mosquito control and since no one else was doing so, he sought out Rollie Dorer and began beating the drums to whip up some interest. He was highly successful, as the present-day control thereabouts testifies, and was President of the VMCA in 1951. Married in 1934, he has a daughter who graduated from the University of North Carolina with a B.Sc. this past June and a son who entered Duke this year.

NOT TO BE OUTDONE BY ITS OLDER AND MORE EXPERIENCED COMPATRIOTS, THE LOUISIANA MOSQUITO CONTROL ASSOCIATION has got out a number of very fine information bulletins on the costs of mosquito control, the methods employed, the actions which can be taken by citizens to assist, and other vital factors in establishing a sound program. More elaborate and of much interest and value to technical people in laboratory and field work, is the LMCA Technical Bulletin No. 1, entitled, "Distribution and Relative Abundance of Mosquito Species in Louisiana," by E. B. JOHNSON, which was kindly sent to us by Professor E. S. HATHAWAY. This slim bulletin gives extensive catch data for each parish and a fine and concise summary of the characteristics of each species in Louisiana. For a group which claims modestly it is still not "off the ground," the LMCA shows a lot of git up and git. They have no paid officials but they must by now have a lot of convinced admirers. In addition to all the above, they also got out mimeographed training material, such as an "Introduction to the Study of Mosquitoes," for use in colleges and high schools.

OUR YOUNG MEMBER, or at least one of our newest, was born in 1934 in Tallahassee, Florida, and received his schooling in that state, culminating in a B.S. and M.S. at the University of Florida. Despite his youth, he has had quite a bit of experience, having spent about 1 year with the Florida State Board of Health, Bureau of Entomology, doing mosquito identification, 6 months with the U. S. Department of Agriculture laboratory at Orlando, 9 months with the State Plant Board and another 9 months with the University's Department of Entomology as a Graduate Assistant. After a tour in the Navy's indoctrination course, he married a pretty lady from Albany, Georgia, and came to California to the Disease Vector Control Center. We guess that about gives it away, if you've read the first part of this column. It's ENSIGN JOHN A. MULRENNAN, JR., we're talking about, and welcome aboard AMCA, too, Johnny!

REVIEWS AND ABSTRACTS

HELEN LOUISE DURKEE

PRELIMINARY OBSERVATIONS ON THE USE OF THE SQUASH TECHNIQUE FOR THE STUDY OF THE CHROMOSOMES OF MOSQUITOES. By Breland, O. P. *Tex. J. Sci.* 11(2):183-190. 1959. The squash technique was used in this work, which was undertaken primarily to determine the most suitable stages and tissues for study, and to develop methods for use in later and more comprehensive investigations.

Dissections were made under 18x magnification on a black background. Instructions for the operation are detailed for larval brain, salivary glands, and Malpighian tubules, and adult ovaries and testes. The tissues were stained with a 1 percent solution of aceto-orcein and a 1 percent solution of aceto-carmin, both of which fixed as well as stained. The brain only was prefixed in a modified Carnoy's fluid to ensure a firmer, opaque tissue, easily discernible and manipulated. Squashing is accomplished by applying pressure to the cover slip which has been placed over the stained tissue.

The author explains that confusion has resulted from the interchange of the terms "smear" and "squash" and points out that smearing is done with an instrument such as a scalpel which spreads out tissue on a slide.

A summary of findings is best given, for the most part, in the author's words:

Orthopodomyia signifera and *O. alba*. Tissue examined: Brains, salivary glands, Malpighian tubules, gastric caeca, and miscellaneous material of 4th instar larvae, including prepupae, brains of pupae; ovaries and testes of newly emerged adults. Results: Mitotic figures observed in brain of prepupae; meiotic figures and mature sperm in testes; meiotic figures in ovaries. Figures quite comparable to the one of *Culiseta inornata*, illustrated in the text, have been seen for both species. The diploid chromosome number of both species of *Orthopodomyia* is 6.

Toxorynchites rutilus septentrionalis: Tissue examined: Brains, salivary glands, and Malpighian tubules of 4th instar larvae; only 2 larvae available. Results: good salivary gland type chromosomes found in Malpighian tubules.

Culiseta inornata: Tissue examined: Brains, salivary glands, and Malpighian tubules of 4th instar larvae including prepupae; only a few larvae available. Results: mitotic figures in the brain of prepupae. The diploid chromosome number is 6.

Culex quinquefasciatus: Tissue examined: Brains and Malpighian tubules of 4th instar larvae, only 2 larvae available; ovaries of one female captured indoors in December. Results: negative.

As always, Dr. Breland has reported in clear, concise manner, some interesting, good work. His paper provides a method of procedure as well as incentive to other investigators.—H. L. T. Durkee.

LA FIEBRE AMARILLA EN MÉXICO Y SU ORIGEN EN AMÉRICA. By Miguel E. Bustamante. Monografía mim. 2. Instituto de Salubridad y Enfermedades Tropicales. Secretaría de Salubridad y Asistencia. Preface by Dr. N. Martínez Báez. I-X. pp. 1-217 incl. index. 19 figs. and large plates with numerous small text illustrations. This epidemiological review begins with comments on Popol-Vuh, the Mayan and Maya-Quicha manuscripts, and includes extracts from the chronicles of the conquerors and friars, extending to the work of Ignacio Fosbo (1871), Ramon Rodriguez Rivera (1877), and Ignacio Alvarado (1878, 1879) that start the Mexican bibliography on yellow fever. Dr. Miguel E. Bustamante gives us his point of view on a theme that has claimed his attention for a long time. There are also numerous references to foreigners which tell their terror and confusion on account of yellow fever, the contemporary of conquerors, slave traders, colonists, adventurers, explorers, etc. To give proportion to the "black vomit," the epidemiological picture includes other plagues, such as small-pox, typhus, and malaria, mentioning royal orders, foundations or locations of towns, hospitals, wars and conquests. There are many necessary references to the Caribbean, Central America, Panama, South America, Canary Islands, etc.

In the first part of this monograph, evidence of the American origin of yellow fever is based on Mayan and Maya-Quicha sources that often refer to epidemic outbreaks of "nekik" or blood-vomit, commonly associated with yellow fever.

The fruitful residence of Dr. Bustamante in the Public Health Unit of the Port of Veracruz, and the importance of this Port, explain the numerous references. Because of deplorable health conditions, it used to be the custom to unload cargo as quickly as possible and to leave the Port immediately for Jalapa, where there was a market for the goods.

Graph no. 1, page 53, presents data to distinguish between the epidemics of yellow fever and malaria, this latter occurring during the second half of the year, while the former shows a climax from June to August.

In the Chapter on Vertebrates and in the Bibliography occur some typographical errors that nevertheless do not diminish the value of this reference.—L. Vargas, Instituto de Salubridad y Enfermedades Tropicales, Mexico, D. F.

REACTIONS OF INSECTS TO THE OLFACTORY STIMULI FROM THE COMPONENTS OF AN INSECTICIDAL SPRAY. By Hocking, B. and Lindsay, I. S. *Bull. ent. Res.* 49(4):675-683. 14 refs. 1958. Clearly, there are components in diesel fuel oil, in the auxiliary solvent tested, and in technical DDT which are markedly repellent to several

insects, including species against which these materials are regularly used. The olfactory response to the completed spray is intermediate between the responses to the ingredients. In the field, this repellent property may be expected to result in a reluctance of insects to settle in a sprayed area (vertical wind-tunnel) and in a tendency to move downward (T-tube).

Although repellent effects of DDT have long been known (Gahan and others, 1945; Kennedy, 1947) the effect reported here differs in that contact with the solid substance was precluded in both methods of test. Equally, in both methods, however, the effect may be due to a relatively volatile impurity, probably without insecticidal activity.

The 3 series of tests with mosquitoes, in which both kinds of equipment were used, all indicated that Velsicol AR50 was considerably more repellent than fuel oil.

Whatever the true nature of the materials which caused the reactions observed, the practical implications are clear: that many spray ingredients contain materials which tend to defeat the object of the spray by inducing such reactions in insects exposed to their vapour that the insect will not come into contact with the toxicant.

This provides an additional argument for the procedure, usually recommended in aerial and sometimes in other methods of spraying, of moving upwind on each successive pass (Anon. 1954), since by this procedure insects repelled

out of the later swaths have to pass through the already sprayed area. With the reverse procedure the odours of the first swath, carried downwind through the target area, would provide warning in time to permit insects to move out through the unsprayed territory. Selective survival of individuals showing these reactions may be a factor in the development of behavioural resistance to insecticides. Our resistant strain of house flies, however, showed a somewhat lower sensitivity than did the supposedly normal strain. It is suggested that the elucidation of the true nature of the materials responsible for these reactions, with a view to eliminating them and perhaps replacing them by attractive ingredients, would be worthwhile.

Two kinds of equipment for measuring the reaction of insects to the olfactory stimuli provided by some common components of insecticidal sprays are described in the text. One of these, consisting of a T-tube carrying a current of odorous air across the top and admitting insects up the stem, is new, can be used in the field, and gives rapid and reproducible evaluation.

Mosquitoes tested were: laboratory-reared *Culex tarsalis* Coq., *Aedes aegypti* (L.), *Aedes* spp., & wild-caught blood hungry females consisting principally of the following species: *A. vexans* (Mg.) *A. stimulans* (Wlk.) *A. excrucians* (Wlk.), *A. fitchii* (Felt & Young), *A. canadensis* (Theo), and *A. intrudens* Dyar.—Excerpts from text, discussion, and summary.

The
Northeastern Mosquito Control Association
WELCOMES
The American Mosquito Control Association
To
BOSTON
for its 16th Annual Meeting

HOTEL SOMERSET

MARCH 27-30, 1960

REFERENCES TO LITERATURE OF INTEREST TO MOSQUITO WORKERS AND MALARIOLOGISTS

HELEN SOLLERS

Plant Pest Control Division, Agricultural Research Service, United States Department of Agriculture

AEROSOLS

PRIVORA, M. and VYCHODIL, J. 1959. Field use of hot oil aerosols. I. Mosquito control. *Ceskoslov. Epidemiol. Microbiol. Imunol. (Praha)* 18(3):208-211. In Czech.

ADULTICIDES AND LARVICIDES

ASSEM, J. VAN DEN. 1959. A window-trap hut experiment to test the effects of dieldrin under local conditions in the Merauke area (Netherlands New Guinea). *Trop. and Geog. Med.* 11(1): 33-43.

CERF, J. and LEBRUN, A. 1959. Note préliminaire sur l'utilisation en pulvérisation domiciliaire d'un insecticide organophosphoré rémanent (Baytex). *WHO Bul.* 20(5):1001-1005.

CHRISTAL, F. A. 1959. Summer huts and spraying campaigns in northern Iraq. *Bul. Endemic Dis. (Baghdad)* 3(1/2):90-95.

DOWLING, M. A. and HUGHES, R. D. 1959. Malaria control by residual spraying reinforced by short-term chemoprophylaxis. *Roy. Army Med. Corps Jour. (London)* 105(2):61-70.

GEROLT, P. 1959. Vapour toxicity of solid insecticides. *Nature (London)* 183(5129):1121-1122.

HOCKING, K. S., ARMSTRONG, J. A. and DOWNING, F. S. 1959. γ -BHC/ 'cereclor' a new long-acting lindane formulation for malaria control. *WHO/Insect./97, WHO/Mal/235*, 15 pp.

JONES, J. C. 1959. Some effects of dieldrin on *Anopheles* mosquitoes. *WHO Bul.* 20(5):987-990.

LEWALLEN, L. L. 1959. Larviciding tests against mosquitoes in California. *Calif. Mosquito Cont. Assoc. Proc.* 27:83.

MARA, L. 1959. Criteria needed before stopping routine annual residual spraying campaigns in eradication programme. *Bul. Endemic Dis. (Baghdad)* 3(1/2):49-58.

MULLA, M. S. and AXELROD, H. 1959. Granular formulations of insecticides and factors influencing their efficiency in mosquito control. *Calif. Mosquito Cont. Assoc. Proc.* 27:79-82.

SHIPITSINA, N. K., DETINOVA, T. S., ET AL. 1959. Protection of construction workers from gnats at the site of the Krasnoyarsk Hydroelectric Power Plant (Siberia). *Med. Parazit. i Parazit. Bolezni* 28(4):456-463. In Rus. [includes *Culiseta* and *Aedes*].

VARIOUS TYPES OF CONTROL

BIDLINGMAYER, W. L. 1959. Mosquito penetration tests with louver screening. *Fla. Ent.* 42(2): 63-67.

BOLLERUD, W. 1959. Evolution of mosquito control in California. *Calif. Mosquito Cont. Assoc. Proc.* 27:15-17.

GREENFIELD, H. R. 1959. Weed control practices by local mosquito control agencies. *Calif. Mosquito Cont. Assoc. Proc.* 27:54-55.

HAUGHTON, F. A., JR. 1959. Soil conservation and mosquito abatement—teamwork in solving water management problems. *Calif. Vector Views* 6(5):29-32.

MUNSON, E. W. 1959. Mosquito control and allied agencies. *Calif. Mosquito Cont. Assoc. Proc.* 27:17-19.

MURRAY, W. D. and WHITTEN, G. 1959. Source reduction in the Delta Mosquito Abatement District. *Calif. Vector Views* 6(7):43-47.

ODGEN, L. J. 1959. Cooperation between Federal agencies (with reference to mosquito problems associated with water resource developments). *Calif. Mosquito Cont. Assoc. Proc.* 27:57-60.

PRINGLE, G. 1959. The role of measures other than residual spraying in malaria eradication operations. *Bul. Endemic Dis. (Baghdad)* 3(1/2): 44-48.

PARASITES AND PREDATORS

KIDDER, G. W. and DUTTA, B. N. 1958. The growth and nutrition of *Crithidia fasciculata*. *Jour. Gen. Microbiol.* 18(3):621-638. [A trypanosomid parasite of mosquitoes.]

LAIRD, M. 1959. Parasites of Singapore mosquitoes, with particular reference to the significance of larval epibionts as an index of habitat pollution. *Ecology* 40(2):206-220.

MAFFI, M. 1959. Primo reperto in Somalia di larve di *A. gambiae* parassitate da funghi del genere *Coelomomyces* Keilin, 1921. *Riv. di Malariol.* 28(1/3):71-76. Engl. Sum.

EQUIPMENT

LONERGAN, R. P. and HALL, L. B. 1959. The regulation of flow through residual spray nozzles. 1. Metering orifices in polyethylene discs. 2. Flow control orifices in soft rubber discs. *WHO Bul.* 20(5):955-959; 961-971.

REPELLENTS

KON, YA, S. and KACHALOVA, E. K. 1959. The experience with insecticide smoke pots in railroad facilities. *Mrd. Parazit. i Parazit. Bolezni* 28(4):488.

RESISTANCE AND SUSCEPTIBILITY

BROWN, A. W. A. 1959. Insecticide resistance as a world problem. *Canad. Jour. Biochem. and Physiol.* 37(9):1091-1097.

CERF, J. and LEBRUN, A. 1959. Résistance de *Culex pipiens fatigans* aux hydrocarbures chlorés à Léopoldville (Congo Belge.). *WHO Bul.* 20(5):994-1001.

CHOW, C. Y. 1959. The appearance of dieldrin-resistance in *Anopheles minimus flavirostris* in the Philippines. *WHO/Mal/241*, 11 pp.

DUPORT, M., SANDULESCO, M., COMBIESCO, I. and CRISTESCO, A. 1959. Irritability of adult *Anopheles* in the presence of DDT. *WHO/Mal/230, WHO/Insect./94*, 5 pp.

ELLIOTT, R. 1959. Insecticide resistance in populations of *Anopheles gambiae* in West Africa. *WHO Bul.* 20(5):777-796.

FRONTALI, N. and CARTA, S. 1959. Studi sulla resistenza degli anofeli agli insetticidi. IV. Declorurazione del DDT in ceppi sensibili e resistenti di *Anopheles atroparvus*. *Riv. di Parasitol.* 20(2):107-110. Engl. Sum.

GÄRMS, R., WEYER, F. and REHM, W. F. 1959. Jahreszeitliche schwankungen der empfindlichkeit gegen DDT bei Freilandpopulationen von *Anopheles atroparvus* und *A. messeae* in Norddeutschland. *Ztschr. f. Tropenmed. u. Parasitol.* 10(1):48-55. Engl. Sum.

GARRETT-JONES, C. 1959. Fifth summary of cases of insecticide resistance and records of susceptibility tests on anopheline mosquitoes. *WHO/Mal/242, WHO/Insect./100*, 19 pp.

HOSKINS, W. M. 1959. Insecticide resistance in agriculture and public health. *Calif. Mosquito Cont. Assoc. Proc.* 27:86-88.

PATEL, T. B., RAMACHANDRA RAO, T., HALGERI, A. V. and DEOBHANKAR, R. B. 1959. A preliminary note on a probable case of dieldrin resistance in *Anopheles culicifacies* in Thana District, Bombay State. *WHO/Mal/225*, 3 pp.

PEFFLY, R. L. 1959. Dieldrin-resistant *Anopheles fluviatilis* in eastern Saudi Arabia. *WHO/Mal/239*, 3 pp.

———. 1959. Insecticide resistance in anophelines in Eastern Saudi Arabia. *WHO Bul.* 20(5):757-776.

SAUTET, J., ALDIGHERI, R., ALDIGHERI, J. and VUILLET, F. 1959. Une nouvelle souche d' *Aedes aegypti* peu sensible au DDT, provenant de Saigon. *Soc. de Path. Exot. Bul.* 52(1):34-36.

SHIDRAWI, G. R. 1959. Notes on the susceptibility of malaria vectors to modern insecticides in Lebanon. *Bul. Endemic Dis. (Baghdad)* 3(1/2):31-38.

SINGH, P. and GAD, A. M. 1959. Susceptibility to DDT of malaria vectors in Jordan. *Bul. Endemic Dis. (Baghdad)* 3(1/2):6-12.

SPILLER, D. 1958. Resistance of insects to insecticides. *N. Zealand Ent.* 2(3):34-51.

UNGUREANU, E. 1959. Observations on the susceptibility of *Anopheles gambiae* to dieldrin assessed by topical application. *WHO Bul.* 20(5):990-994.

VARGAS, L., ROMÁN Y CARRILLO, G. and DÍAZ NÁJERA, A. 1959. Nuevas técnicas para estudiar la susceptibilidad de artrópodos a insecticidas persistentes. I. Pruebas en 4 especies anofelinas Mexicanas criadas en el laboratorio basadas en el tiempo de caída definitiva de los ejemplares. *Rev. Inst. Salubridad Enferm. Trop. (Mexico)* 19(1):19-65.

WHO MALARIA ADVISORY TEAM No. 2. 1959. Results of resistance tests on anophelines in Iraq. *Bul. Endemic Dis.* 3(1/2):129-133.

ZULUETA, J. DE. 1959. Insecticide resistance in *Anopheles sacharovi*. *WHO Bul.* 20(5):797-822.

PAPERS ON RESISTANCE FROM INDIAN JOUR. MALARIOL. 12(4):

ASCHER, K. R. S. 1958. A common information source for all resistance problems in biology is urgently needed in view of the paucity of effective countermeasures to insecticide-resistance! pp. 615-625.

BABERS, F. H. 1958. Biochemistry and physiology of resistance by insects to insecticides. pp. 517-529.

BHATIA, S. C., DEOBHANKAR, R. B. and VITTAL, M. 1958. Susceptibilities of mosquitoes to D.D.T. and dieldrin in sprayed and unsprayed areas of Bombay State. pp. 371-376.

BLÁZQUEZ, J. 1958. Tests with larvae of *Aedes, Culex*, and *Anopheles* in Venezuela. pp. 323-329.

BRADBURY, F. R., CAMPBELL, A. and O'CARROLL, F. M. 1958. The waxes and lipids of resistant houseflies and mosquitoes. pp. 547-564.

BUSVINE, J. R. 1958. Experiments concerned with the development of the World Health Organization test for resistance in adult mosquitoes. pp. 279-286.

——— and PAL, R. 1958. Resistance of insects to insecticides. A note on terminology. pp. 265-267.

CHOW, C. Y. 1958. Insecticide susceptibility and resistance in anopheline mosquitoes in Java. pp. 345-366.

COVA GARCIA, P. 1958. Resistance manifestations in the behaviour of the vectors in Venezuela. pp. 331-339.

DAVIDSON, G. 1958. The practical implications of studies on insecticide resistance in anopheline mosquitoes. pp. 413-422.

FISK, F. W. 1958. Techniques for the measurement of insecticide resistance in mosquitoes as they relate to the principles of bioassay. pp. 287-293.

GANGULI, N. and SINHA, G. C. 1958. Susceptibility to D.D.T. of principal malaria vectors of West Bengal. pp. 377-382.

HAWKINS, W. B., MOORE, J. B. and SMITH, G. E. 1958. Tests on the resistance of *Anopheles*

larvae in the region of the Tennessee Valley Authority. pp. 317-322.

JUCCI, C. 1958. Physiogenetic researches on resistance of insects (mosquitoes, flies, termites and silkworms) to insecticides. The effects of pre-treatment with neurotropic drugs in *Bombyx mori*. pp. 475-479.

KOSHI, T. and RANGANATHAN, S. K. 1958. Influence of relative humidity on the normal tolerance of the mosquito, *Culex fatigans*, Wied., to D.D.T. pp. 589-600.

LAVEN, H. and PAL, R. 1958. Outline for the study of population genetics of resistance. pp. 481-491.

MATHIS, W. and SCHOOF, H. F. 1958. Field effectiveness of malathion deposits against dieldrin resistant *Anopheles quadrimaculatus*. pp. 433-437.

MORRISON, F. O. 1958. The influence of the test method on the degree of insecticidal resistance reported. pp. 303-307.

NERI, I., ASCHER, K. R. S. and MOSNA, E. 1958. Studies on insecticide-resistant anophelines. III. A preliminary report on lipid content in some strains of *A. atroparvus*. pp. 565-570.

OPPENORTH, F. J. and DRESDEN, D. 1958. Discussion of some methods for the measurement of degrees of resistance. pp. 309-315.

PAL, R. 1958. Biochemistry of resistance to organophosphorus compounds. pp. 539-546.

———. 1958. Present status of susceptibility of some species of mosquitoes to D.D.T., B.H.C. and dieldrin. pp. 383-399.

——— and KALRA, R. L. 1958. Comparative susceptibility of D.D.T.-resistant and normal *Culex fatigans* larvae to diphenyl methane derivatives, chlorinated hydrocarbons and organophosphorus insecticides. pp. 439-445.

PAL, R. and KRISHNAMURTHY, B. S. 1958. Crossability and inter-specific fertility of mosquitoes *Culex p. molestus* and *Culex fatigans*. pp. 493-497.

PAL, R. and SINGH, N. N. 1958. Inheritance of D.D.T.-resistance in *Culex fatigans*. pp. 499-516.

PANT, C. P. 1958. Biochemical mechanisms of insecticide resistance. pp. 531-537.

PATEL, T. B., RAMACHANDRA RAO, T., HALGERI, A. V. and DEOBHANKAR, R. B. 1958. A preliminary note on a probable case of dieldrin resistance in *Anopheles culicifacies* in Thana district, Bombay State. pp. 367-370.

RAO, B. A. 1958. Special number of Indian Journal of Malariology on resistance of insects to insecticides. Introduction. pp. 261-263. [Editorial.]

SAUTET, J., ALDIGHERI, J. and ALDIGHERI, R. 1958. Resistance to insecticides is a danger in the struggle against diseases transmitted by insects, in view of the rapidity of its acquisition and its impenetrability. pp. 611-614.

SHARMA, M. I. D. 1958. Laboratory and field development of resistance in mosquitoes. pp. 401-411.

SMITH, A. 1958. Dieldrin resistance in *Culex pipiens fatigans* in north eastern Tanganyika. pp. 341-343.

SOLLERS, H. 1958. Selected references on resistance of mosquitoes to insecticides, 1954 through September 1958. pp. 627-636.

SPILLER, D. 1958. Components of insecticide tolerance. pp. 571-578.

UNGUREANU, E. and COWORKERS. 1958. Susceptibility and seasonal tolerance of local adult *Anopheles* to long-time use of D.D.T. and B.H.C. pp. 601-609.

WRIGHT, J. W. 1958. Standard test methods for detecting and measuring the resistance of insects to insecticides. pp. 269-277.

INSECTICIDES AND CHEMICALS

BERTAGNA, P. 1959. Residual insecticides and the problem of sorption. WHO Bul. 20(5):861-889.

MILES, J. W., GOETTE, M. B., GRIMM, L. and PEARCE, G. W. 1959. Factors affecting the susceptibility of DDT water-dispersible powders. WHO Bul. 20(5):937-945.

PEARCE, G. W., GOETTE, M. B. and SEDLAK, V. A. 1959. Storage stability of DDT water dispersible powders. WHO Bul. 20(5):921-936.

PEARCE, G. W., GOODEN, E. L. and JOHNSON, D. R. 1959. Specifications of the International Cooperation Administration for DDT water-dispersible powder for use in malaria control programmes. WHO Bul. 20(5):913-920.

PEARCE, G. W., MILES, J. W. and GOETTE, M. B. 1959. Factors affecting the susceptibility of dieldrin water-dispersible powders. WHO Bul. 20(5):947-953.

SHEPARD, H. H., MAHAN, J. N. and GRAHAM, C. A. 1959. The pesticide situation for 1958-59. U. S. Dept. Agr. Comm. Stab. Serv., 24 pp.

TOXICOLOGY

HAYES, W. J., JR. 1959. The toxicity of dieldrin to man. Report of a survey. WHO Bul. 20(5):891-912.

WEBBE, G. and SHUTE, G. T. 1959. A further note on the action on fish of chlorinated hydrocarbons when used as larvicides. Ann. Trop. Med. and Parasitol. 53(1):47-50.

WORLD HEALTH ORGANIZATION. 1959. Bibliography on pesticides toxicity and accidental poisoning. WHO/Insect/98, 9 pp.

———. 1959. Information circular on the toxicity of pesticides to man. No. 3, 15 pp. (Div. Environmental Sanit.).

BIOLOGY AND ECOLOGY

AL-AZAWI, A. and CHEW, R. M. 1959. Notes on the ecology of the dark rice field mosquito, *Psorophora confinnis*, in Coachella Valley, California (Diptera:Culicidae). Ent. Soc. Amer. Ann. 52(4):345-351.

BULLOCK, H. R., MURDOCH, W. P., FOWLER, H. W. and BRAZZEL, H. R. 1959. Notes on the overwintering of *Culex tritaeniorhynchus* Giles in Japan. Mosquito News 19(3):184-188.

CHAPMAN, H. C. 1959. Observations on the salinity on natural and impounded salt-marsh areas in New Jersey in relation to vegetation, mosquitoes and predators. Mosquito News 19(3):148-150.

DOBY, J. M., DAVID, F. and RAULT, B. 1958. Contribution à l'étude faunistique et écologique des culicides et simuliides (Diptera Nematocera) de Belle-Ile (Morbihan). Cahiers des Nat. (n.s.) 14(4):94-98.

GERHARDT, R. W. 1959. The influence of soil fermentation on oviposition site selection by mosquitoes. Mosquito News 19(3):151-155.

HUSBANDS, R. C. 1959. Preliminary studies of the gonotrophic cycle of *Aedes nigromaculis* (Ludlow) (Diptera: Culicidae). Calif. Mosquito Cont. Assoc. Proc. 27:73-77.

ILVIN, N. P. 1959. On the phenology of blood-sucking mosquitoes in the vicinity of the city of Kaluga. Med. Parazit. i Parazit. Bolezni 28(4):487-488. In Rus. [*Aedes*, *Culex*].

KHELEVIN, N. V. 1958. The effect of environmental factors on the embryonic diapause and on the number of generations during one season in *Aedes caspius dorsalis* Mg. (Diptera, Culicidae). Ent. Obozr. 37(1):24-26. In Rus., Engl. Sum.

———. 1959. The seasonal character of hatching and the embryonic diapause in *Aedes caspius dorsalis* Mg. (Diptera, Culicidae). Ent. Obozr. 38(2):394-407. In Rus., Engl. Sum.

LIU, E. P. and CHEN, C. S. 1959. A preliminary report on the study of the hibernation of *Anopheles hyrcanus* var. *sinensis* in Chia-Hsing, Chekiang. Acta Ent. Sinica 9(1):75-84. In Chin., Engl. Sum.

LOOMIS, E. C. and GREEN, D. H. 1959. Ecological observations on *Culex tarsalis* Coquillett and other mosquitoes in the Delta Region of the Central Valley of California, 1953-1956 (Diptera: Culicidae). Ent. Soc. Amer. Ann. 52(5):524-533.

MARCHAL, E. 1959. Variation de la population anophélienne d'une mare à salinité variable de la région de Konakri (Guinée Française). Inst. Franç. d'Afrique Noire Bul. Ser. A. 21(1):180-203.

MCCLELLAND, G. A. H. 1959. Observations on the mosquito, *Aedes (Stegomyia) aegypti* (L.), in East Africa. I. The biting cycle in an outdoor population at Entebbe, Uganda. Bul. Ent. Res. 50(2):227-235.

MILLER, L. 1959. A note on *Mansonia* breeding in Oregon log ponds. Mosquito News 19(3):198.

NAIEV, G. M. 1959. On the ecology and the summer and autumn phenology of *Anopheles maculipennis* Mg. var. *subalpinus* H. L. (Diptera, Culicidae) in the south-eastern (Maritime) part of Azerbaijan. Ent. Obozr. 38(2):408-423. In Rus., Engl. Sum.

O'CONNOR, C. T. 1959. The life history of *Mochlonyx cinctipes* (Coquillett) (Diptera: Culicidae). Ent. Soc. Amer. Ann. 52(5):519-523.

RAGAB, H. A. A. 1958. Effect of the *Plasmodium* on the transmitting mosquito host from the point of view of the longevity of the infected mosquito. Egyptian Med. Assoc. Jour. 41(9/10):447-454.

RONNEFELDT, F. 1959. *Anopheles sundanicus* (Rodenwaldt 1926) al malariaüberträger in Mittel-Java. Ztschr. f. Tropenmed. u. Parasitol. 10(1):38-47. Engl. Sum.

SZTANKAY-GULYÁS, M. and ZOLTAI, N. 1959. Die brütung der mückenlarven und ihre bekämpfung aus reisfeldern. Acta Zool. (Budapest) 4(3/4):421-428. [*Anopheles*].

ZANINA, Z. L. 1958. Some characteristic biological features of *Anopheles bifurcatus* L. (Diptera, Culicidae) in Rushan District (Western Pamirs). Ent. Obozr. 37(4):856-868. In Rus., Engl. Sum.

GENETICS

RISLER, H. 1959. Polyploidie und somatische reduktion in der larvenepidermis von *Aedes aegypti* L. (Culicidae). Chromosoma 10(2):184-209.

BEHAVIOR

LIU, C. W., CHANG, S., CHENG, Y. K. and WANG, Y. M. 1959. Studies on vectors of Japanese B encephalitis virus in Peking. II. Studies on the blood feeding habits of common species on mosquitoes in Peking. Acta Ent. Sinica 9(1):50-56. In Chin., Engl. Sum.

O'GOWER, A. K. 1958. The oviposition behaviour of *Aedes australis* (Erickson) (Diptera, Culicidae). Linn., Soc. N. S. Wales, Proc. 83(3):245-250.

See also McClelland under Biology and Ecology.

ANATOMY, MORPHOLOGY AND PHYSIOLOGY

AVI-DOR, Y. and GONDA, O. 1959. Studies on the adenosine triphosphate-phosphate exchange and the hydrolysis of adenosine triphosphate catalysed by a particulate fraction from the mosquito. Biochem. Jour. 72(1):8-14.

BERTRAM, D. S. 1959. The ovary and ovarioles of mosquitoes (an illustrated note, with glossary). WHO/Mal/236, 18 pp.

CORBET, P. S. 1959. Recognition of individual nulliparous and parous mosquitoes. Roy. Soc. Trop. Med. and Hyg. Trans. 53(3):297.

KARDOS, E. H. 1959. The effect of larval nutritional level on development of autogeny in colony *Culex tarsalis* Coq. Calif. Mosquito Cont. Assoc. Proc. 27:71-72.

LEBIED, B. 1959. Détermination de l'âge physiologique des diptères. Nouvelle méthode

basée sur la recherche des vestiges du processus de l'ovulation. Riv. di Parassitol. 20(2):91-106. Engl. Sum.

ROSAY, B. 1959. Expansion of eggs of *Culex tarsalis* Coquillett and *Aedes nigromaculis* (Ludlow) (Diptera: Culicidae). Calif. Mosquito Cont. Assoc. Proc. 27:72-73.

———. 1959. Gross external morphology of embryos of *Culex tarsalis* Coquillett (Diptera: Culicidae). Ent. Soc. Amer. Ann. 52(4):481-484.

ROUBAUD, E. and GHELELOVITCH, S. 1959. Les indices maxillaires dans l'interprétation du complexe biologique, chez le moustique commun, European *Culex pipiens* L. Acad. des Sci. Compt. Rend. 248(25):3510-3513.

SNODGRASS, R. E. 1959. The anatomical life of the mosquito. U. S. Smithson. Misc. Coll. 139(8): 87 pp., 30 illus.

VENDRELY, C. and CALLOT, J. 1958. Étude du contenu en ADN des noyaux de différents tissus chez le moustique *Culex pipiens pipiens*. Soc. de Biol. (Paris) Compt. Rend. 152(12):1803-1806. [Desoxyribonucleic acid.]

TECHNIQUES

AVERY-JONES, S. and LOWY, L. 1959. Technique of collection and examination of thick blood films for malaria parasites. (With a modification of the J. S. B. staining method.) WHO/Mal/232, 13 pp.

BRELAND, O. P. 1959. Preliminary observations on the use of the squash technique for the study of the chromosomes of mosquitoes. Tex. Jour. Sci. 11(2):183-190.

CHAO, J. 1959. Notes on the techniques of handling mosquitoes in the laboratory. Mosquito News 19(3):191-193.

DIVISION OF MALARIA ERADICATION, WHO; and LISTER INSTITUTE OF PREVENTIVE MEDICINE, U. K. 1959. Study of blood feeding patterns of *Anopheles* mosquitoes as a guide to the strategy of malaria eradication. (Results of work for the period 1955-1958.) Preliminary report. WHO/Mal/234, 51 pp. plus appendices. [Prepared by L. J. Bruce-Chwatt and C. W. Gökcl.]

FAY, R. W., BAKER, J. T. and JENSEN, J. A. 1959. Radioactive tagging of *Culex quinquefasciatus* (Say) with P³². Mosquito News 19(3):139-143.

FAY, R. W. and MORLAN, H. B. 1959. A mechanical device for separating the developmental stages, sexes and species of mosquitoes. Mosquito News 19(3):144-148.

FURTUNESCU, G. 1959. Cages pliantes pour le transport des culicidés et autres diptères. WHO Bul. 20(5):1007-1009.

MURRAY, W. D. 1959. Measuring adult populations of the pasture mosquito, *Aedes nigromaculis* (Ludlow). Calif. Mosquito Cont. Assoc. Proc. 27:67-71.

PAVLOVSKII, E. N. (Editor). 1959. Laboratory practice in medical parasitology. 487 pp., Medgiz. In Rus.

UNGUREANU, E. and UNGUREANU, L. 1959. Une micropipette pour l'application topique de très petites quantités d'insecticide. WHO Bul. 20(5): 1005-1007.

WHARTON, R. H. 1959. A simple method of mounting and preserving filarial larvae. WHO Bul. 20(4):729-730.

WHITTAM, D. and HIGGINS, A. H. 1959. A device for evaluating deposits of granulated pesticides. U. S. Dept. Agr., Agr. Res. Serv., ARS 81-7, 4 pp.

TAXONOMY

BAILLY-CHOUMARA, H. and ADAM, J. P. 1959. *Anopheles maliensis* n. sp. (Diptera Culicidae), une espèce nouvelle d'anophélins du Fouta-Djallon (Republique de Guinée) Acad. des Sci. Compt. Rend. 248(26):3742-3743.

DOBROWORSKY, N. V. 1957. Notes on Australian mosquitoes (Diptera, Culicidae). III. The subgenus *Lophoceraomyia* in Victoria. Linn. Soc. N. S. Wales Proc. 82(385):317-318. Pub. 1958. [*Culex orbosienensis* n. sp.]

FOOTE, R. H. and COOK, D. R. 1959. Mosquitoes of medical importance. U. S. Dept. Agr. Handbook 152, 158 pp.

HARA, J. 1959. Taxonomical notes on the female terminalia of some anopheline mosquitoes of Japan and Formosa. Taxonomical and ecological studies on mosquitoes of Japan, 12. Japan. Jour. Expt. Med. 29(2):107-119.

HEDEEN, R. A. 1959. A review of the mosquito larvae of France. II. The genus *Aedes*. Mosquito News 19(3):179-183.

LAARMAN, J. J. 1959. A new species of *Anopheles* from a rain-forest in Eastern Belgian Congo. Trop. and Geog. Med. 11(2):147-156. [*A. vanthieli*.]

MATTINGLY, P. F. 1958. An important problem of mosquito nomenclature. Roy. Ent. Soc. London Proc. Ser. C., J. Mtg. 22(5):23-24.

MENG, C. H. 1958. A new species of *Culex*. Acta Ent. Sinica 8(4):351-354. In Chin., Engl. Sum. [C. *huangae*.]

RIOUX, J. A., RUFFIÉ, J. and PECH, J. 1959. Evolution des idées en entomologie médicale; le problème du complexe *maculipennis*. Biologie Médicale (Paris) 48(3):215-237.

STONE, A., KNIGHT, K. L. and STARCKE, H. 1959. A synoptic catalog of the mosquitoes of the world. Thomas Say Foundation Vol. 6, 358 pp. (Ent. Soc. Amer., Wash. D. C.)

DISTRIBUTION

ASSEM, J. VAN DEN. 1959. Some notes on mosquitoes collected on Frederik Hendrik Island (Netherlands New Guinea). Trop. and Geog. Med. 11(2):140-146.

BOHART, R. M. 1959. A survey of the mosquitoes of the southern Ryukyus. Mosquito News 19(3):194-197.

CHAPMAN, H. C. 1959. A list of Nevada mosquitoes, with five new records. Mosquito News 19(3):155-156.

- GRAHAM, J. E. 1959. The current status of *Aedes nigromaculis* (Ludlow) in Utah. Calif. Mosquito Cont. Assoc. Proc. 27:77-78.
- Hsu, K. C. and COWORKERS. 1959. A report on the species and ecology of mosquitoes in Chengtu, Szechwan, China. Acta Ent. Sinica 9(1):85-92. In Chin., Engl. Sum.
- LAKE, R. W. 1959. Discovery of *Mochlonyx fuliginosus* (Felt) in Passaic County, New Jersey. Mosquito News 19(3):198.
- LUKASIAK, J. 1959. Aggressive mosquitoes of the Krynica Morska area, Gdańsk Province. Wiad. Parazytol. 5(1):25-27. In Pol., Engl. Sum.
- NOVÁK, D. 1958. Beitrag zur verbreitung der stechmücken *Aedes (O.) cataphylla* Dyar in Mähren. Zool. Listy 7(4):355-356. In Czech., Ger. Sum.
- . 1958. Beitrag zur verbreitung von *Culex modestus* Fic. in Mähren. Zool. Listy 7(4):353-354. In Czech., Ger. Sum.
- RAPP, W. F., JR. 1959. A distributional checklist of Nebraska mosquitoes. Kans. Ent. Soc. Jour. 32(3):128-133.
- SENEVET, G. and ANDARELLI, L. 1959. Les moustiques de l'Afrique du Nord et du Bassin Méditerranéen. Les genres *Culex*, *Uranotaenia*, *Theobaldia*, *Orthopodomyia* et *Mansonia*. Encyclopédie Ent. 37, 383 pp.
- SENEVET, G., CLASTRIER, J. and MORVAN, R. 1959. Une nouvelle station de *Anopheles (Myzomyia) d'thali* Patton dans le Sahara Français. Inst. Pasteur d'Algerie Arch. 37(1):165-166.
- SHAW, F. R. 1959. New records and distributions of the biting flies of Mt. Desert Island, Maine. Mosquito News 19(3):189-191. [Includes mosquitoes.]
- SURTEES, G. 1959. The genus *Uranotaenia* Lynch Arribalzaga 1891 (Diptera:Culicidae) in West Africa. West Afr. Med. Jour. 8(2):47-52.
- TEESDALE, C. 1959. Observations on the mosquito fauna of Mombasa. Bul. Ent. Res. 50(1):191-208.
- WU, C. C. 1959. A preliminary report on the mosquitoes of eight districts of Hupeh Province. Acta Ent. Sinica 9(1):100. In Chin.
- WU, C. Y. 1959. A preliminary mosquito survey in Chinping, Kweichow Province. Acta Ent. Sinica 9(1):57-65. In Chin., Engl. Sum.
- See also Foote and Cook, and Hedeon under Taxonomy.
- ERN EQUINE ENCEPHALITIS. Rocky Mountain Med. Jour. 56(4):68-71.
- GALINDO, P., RODANICHE, E. DE and JOHNSON, C. M. 1959. St. Louis encephalitis in Panama. I. Isolation of the virus from forest mosquitoes and human blood. Amer. Jour. Trop. Med. and Hyg. 8(5):557-560.
- GIDDINGS, L. E., SMITH, L. W., BEAVER, M. E. and SOOTER, C. A. 1959. St. Louis encephalitis outbreak during 1956 in Grand Junction, Colo. U. S. Pub Health Rpts. 74(4):372-375.
- LONGSHORE, W. A., JR. 1959. The encephalitis problem in California. California's Health 16(16):120-125.
- and COWORKERS. 1959. Transplacental passage of antibody to western equine encephalitis viruses. Amer. Jour. Trop. Med. and Hyg. 8(4):424-432.
- RAPP, W. F. 1959. Arthropod-borne encephalitis in Nebraska—A review. Nebr. State Med. Jour. 44(8):393-396.
- REES, D. M. and COLLETT, G. C. 1959. Factors influencing the encephalitis outbreak in Utah in 1958. Calif. Mosquito Cont. Assoc. Proc. 27:88-97.
- REEVES, W. C. 1959. The next step in encephalitis research in Kern County. Calif. Mosquito Cont. Assoc. Proc. 27:97-99.
- SUDIA, W. D. and CHAMBERLAIN, R. W. 1959. The virus of St. Louis encephalitis in chickens. Amer. Jour. Hyg. 70(2):197-207.
- WALLIS, R. C. 1959. *Culiseta melanura* (Coquillett) and eastern equine encephalitis in Connecticut. Mosquito News 19(3):157-158.

FILARIASIS

- CH'EN, T. H. 1959. Local hetrazan-novocaine solution injection into lymph nodes in the treatment of Bancroft's filariasis. Chinese Jour. Intern. Med. (Peking) 7(2):180. In Chin.
- CHOW, C. Y., JOE, L. K., WINOTO, R. M. P. and SOEGIARTO, M. RUSAD. 1959. The vector of filariasis in Djakarta and its bionomics. WHO Bul. 20(4):667-676.
- CHUN-SYUN, F. 1959. On the spread of *Dirofilaria repens* in Kazkhstan. Med. Parazit. i Parazit. Bolezni 28(4):483. In Rus.
- JORDAN, P. 1959. A note on the effect of a blood meal on infective larvae of *Wuchereria bancrofti* in *Culex fatigans*. Roy. Soc. Trop. Med. and Hyg. Trans. 53(2):148-150.
- . 1959. The possible role of low-density microfilaraemia in the spread of *Wuchereria bancrofti* by *Culex fatigans* in East Africa. Ann. Trop. Med. and Parasitol. 53(1):42-46.
- LI, H. H. 1959. Prevention and treatment of filariasis in Shantung Province. Chinese Med. Jour. (Peking) 78(1):52-54.
- LI, L. S. and COWORKERS. 1959. Studies on the dosage and effect of hetrazan in filariasis. Chinese Jour. Intern. Med. (Peking) 7(1):60-67. In Chin., Engl. Sum.

ENCEPHALITIS

MANSON-BAHR, P. 1959. The story of *Filaria bancrofti*. Part III. Advances in the 20th century. Part IV. Mosquito intermediaries of *W. bancrofti*. Part V. Description of *W. bancrofti* and pathology of filariasis. Jour. Trop. Med. and Hyg. (London) 62(5):106-117; 62(6):138-145; 62(7):160-176.

RACHOU, R. G., PIRES, W. M. and MOURA LIMA, M. 1958. Filariose bancroftiana em São Luiz, Maranhão: resultado de inquérito feito em 1957. Rev. Brasil. de Malariol. 10(1):61-64.

ROOK, H. DE and DIJK, J. O. M. VAN. 1959. Changing concept of *Wuchereria bancrofti* transmission in Netherlands New-Guinea. Trop. and Geog. Med. 11(1):57-60.

SIPAHIÖGLÜ, H. 1959. Studies on filariasis in Turkey. Roy. Soc. Trop. Med. and Hyg. Trans. 53(2):151-153.

TURNER, L. H. 1959. Studies on filariasis in Malaya; the clinical features of filariasis due to *Wuchereria malayi*. Roy. Soc. Trop. Med. and Hyg. Trans. 53(2):154-169.

WANG, C. F., LIN, C. L. and CH'EN, W. H. 1959. Some problems on the mechanism of microfilarial periodicity. Chinese Jour. Intern. Med. (Peking) 7(3):245-247. In Chin., Engl. Sum. pp. 22-23.

MALARIA

AL-HAMMAMI, A. 1959. Legislative needs in malaria programme in Iraq. Bul. Endemic Dis. (Baghdad) 3(1/2):1-5.

CHINESE MEDICAL JOURNAL. 1959. Malaria, ancylostomiasis and filariasis basically eliminated in Shanghai suburbs. Chinese Med. Jour. (Peking) 78(1):49-51.

COLLIGNON, E. and JUILLAN, M. 1959. Les indices endémiques palustres du personnel sédentaire de la station expérimentale du Marais des Ouled Mendil en 1958. Inst. Pasteur d'Algerie Arch. 37(1):53-54.

DUNN, F. L. and BRODY, J. A. 1959. Malaria surveillance in the United States, 1956-1957. Amer. Jour. Trop. Med. and Hyg. 8(4):447-455.

FARJO, P. 1959. Malaria precautions to be taken during pilgrimages in Iraq. Bul. Endemic Dis. (Baghdad) 3(1/2):88-89.

LUPASCU, G. and COWORKERS. 1958. Contributions à l'étude de la malaria dans le bassin hydrographique Crisul Alb. Microbiol. Parazit. Epidemiol. (Bucharest) 3(4):339-357. In Roum.

MAFFI, M. 1959. Somalia—the status of the antimalaria control programme and the plan for future action. Bul. Endemic Dis. (Baghdad) 3(1/2):76-87.

METSelaar, D. and THIEL, P. H. VAN. 1959. Classification of malaria. Trop. and Geog. Med. 11(2):157-161.

MOFIDI, C. M. H. 1959. The training programme for malaria personnel in Iran. Bul. Endemic Dis. (Baghdad) 3(1/2):96-104.

PANOS, Z. G. 1959. The activities and cost of maintaining a malaria-free status in Cyprus

since the eradication of malaria in 1950. Bul. Endemic Dis. (Baghdad) 3(1/2):39-43.

RADACOVICI, E. and COWORKERS. 1958. Étude de l'évolution de l'endémie palustre dans la zone du bassin hydrographique du Danube, Oltenia-Galati, dans l'intervalle 1949-1957. Microbiol. Parazit. Epidemiol. (Bucharest) 3(4):329-338. In Roum.

SHEMELININ, S. P. 1959. It is yet too early to consider malaria fully controlled. Med. Parazit. i Parazit. Bolezni 28(4):482. In Rus.

SMITH, A. and DRAPER, C. C. 1959. Malaria in the Taveta area of Kenya and Tanganyika. I. Epidemiology. East Afr. Med. Jour. 36(2):99-113.

TABIBZADEH, A. 1959. Organization and progress of surveillance programme in Iran. Bul. Endemic Dis. (Baghdad) 3(1/2):105-110.

VELLA, E. E. 1958. Malaria in an army community. West Afr. Med. Jour. (n.s.) 7(3):143-150.

WORLD HEALTH ORGANIZATION. 1959. Malaria information. WHO Mal/Inform/48, 13 pp. [Malaria eradication discussion, possible automatic screening method for detection of malaria, *Anopheles pampanai* et al.]

———. 1959. Malaria information. WHO Mal/Inform/49, 14 pp. [Data on 7th Bornco Malaria Conf., investigations in northern Somalia, et al.]

———. 1959. Malaria in the People's Republic of China. WHO Mal/Inform/47, 14 pp.

———. 1959. Report of the Third Asian Malaria Conference, WHO. New Delhi, 16-21 March 1959. WHO/Mal/226, 79 pp.

———. 1959. Resolutions and decisions of the Twelfth World Health Assembly Geneva, 12-29 May 1959. WHO Off. Rec. 95, 52 pp.

ZAHIR, A. R. and DABBAGH, H. S. 1959. A malaria survey in north western part of Saudi Arabia. Bul. Endemic Dis. (Baghdad) 3(1/2):111-128.

Malaria—Eradication Projects

CEFALÙ, M. and GULOTTA, A. 1959. Su di un episodio epidemico occorso in fase di eradicazione della malaria in Sicilia. Riv. di Malariol. 28(1/3):45-70. Engl. Sum.

CIUCA, M. 1958. Malaria eradication. IV. The "transmission" problem and the incidence of malaria after the first 3 years of the "attack phase"—determining factors in planning the campaign for the next years. Microbiol. Parazit. Epidemiol. (Bucharest) 3(4):319-327. In Roum.

FAKIR, M. T., EL. 1959. Progress of malaria eradication program in Syria. Bul. Endemic Dis. (Baghdad) 3(1/2):64-70.

GARRETT-JONES, C. 1959. The place of entomology in malaria eradication. WHO/Mal/231, 8 pp.

POSTIGLIONE, M. 1959. Strategy in planning eradication measures in areas of hyp endemic malaria. Bul. Endemic Dis. (Baghdad) 3(1/2):59-63.

RAFI, S. M. 1958. Role of nomads in re-introduction of malarial infection to West Pakistan in an eradication campaign. *Pakistan Jour. Health* 8(1):22-24.

RIADH, H. 1959. Difficulties in malaria eradication programmes. *Bul. Endemic Dis.* (Baghdad) 3(1/2):134-137.

SHAMI, K. 1959. The necessity of public health administrative reforms in implementing a malaria eradication programme. *Bul. Endemic Dis.* (Baghdad) 3(1/2):13-18.

SOBKY, M. F. 1959. The malaria problem in Egypt and the preliminary planning for its eradication by stages. *Bul. Endemic Dis.* (Baghdad) 3(1/2):19-27.

VARGAS, L. 1959. Principios generales sobre busqueda de casos en una campaña de erradicación del paludismo. *Rev. Inst. Salubridad Enferm. Trop.* (Mexico) 19(1):71-95. Engl. Sum.

YEKUTIEL, P. and GÖCKEL, C. W. 1959. Analysis of data on evaluation and surveillance quoted in the report on development of malaria eradication programme presented to the Twelfth World Assembly—May 1959. *WHO/Mal/229*, 14 pp.

Malaria—*Plasmodia*

BASTIANELLI, G. 1959. Il globulo rosso e il metabolismo del parassita malarico. *Riv. di Malariol.* 38(1/3):9-26.

CERNÁ, Z. 1958. Observations on *Plasmodium* infection in partridges. *Vestn. Českoslov. Zool. Spol.* (Prague) 22(1):73-78. In Czech., Ger. Sum.

CLYDE, D. F. and SHUTE, G. T. 1959. Survival of pyrimethamine-resistant *Plasmodium falciparum*. *Roy. Soc. Trop. Med. and Hyg. Trans.* 53(2):170-172.

COWPER, S. G. and WOODWARD, S. F. 1959. Observations on *Plasmodium berghei* infection in white rats: blood changes and acquired resistance. *Ann. Trop. Med. and Parasitol.* 53(1):103-112.

DEMINA, N. A. 1959. Contribution à l'étude de l'influence du régime nyctéméral de l'hôte sur l'évolution de la multiplication de *Plasmodium relictum*. *Riv. di Malariol.* 38(1/3):27-44. Engl. Sum.

JEFFERY, G. M., YOUNG, M. D., BURGESS, R. W. and EYLES, D. E. 1959. Early activity in sporozoite-induced *Plasmodium falciparum* infections. *Ann. Trop. Med. and Parasitol.* 53(1):51-58.

McGHEE, R. B. 1959. The effect of lowered temperatures of the host on the reproductive activity of *Plasmodium cathemerium*. *Jour. Protozool.* 6(1):84-88.

NAKAMURA, S. 1958. Infection of *Plasmodium berghei* (rodent malaria Protozoa) in mouse body and relationship to health hazard insects. *Jour. Osaka City. Med. Center* 7(1):45-61. In Jap., Engl. Sum.

VAN DEN BERGHE, L., LAMBRECHT, F. L. and ZAGHI, A. 1958. Démonstration du cycle sexué de *Plasmodium antheruri* n. sp. au Congo Belge.

Soc. Belge de Méd. Trop. Ann. 38(5):977-981. Engl. Sum.

VAN DEN BERGHE, L., PEEL, E., CHARDOME, M. and LAMBRECHT, F. L. 1958. Le cycle asexué de *Plasmodium antheruri* n. sp. du porc-épic *Antherurus africanus centralis* au Congo Belge. *Soc. Belge de Méd. Trop. Ann.* 38(5):971-975.

See also Ragab under Biology and Ecology.

Malaria—Therapeutics and Antimalarials

ADAMS, A. R. D. 1959. Drug treatment of malaria. *Brit. Med. Jour.* 5145:183-184.

ARCHIBALD, H. M. and ROBERTSON, A. M. 1959. Field trials of some new antimalarial compounds. *WHO/Mal/237*, 8 pp.

BRUCE-CHWATT, L. J. 1959. Assessment of urinary excretion of antimalarial drugs in large-scale chemotherapeutic eradication projects. *WHO Bul.* 20(5):973-985.

GABALDON, A. and GUERRERO, L. 1959. An attempt to eradicate malaria by the weekly administration of pyrimethamine in areas of out-of-doors transmission in Venezuela. *Amer. Jour. Trop. Med. and Hyg.* 8(4):433-439.

GLADIKIH, V. F., KELLINA, O. I. and KOROGODINA, YU. V. 1959. Some data on the tolerance of laboratory animals to cyclochin—an antimalarial preparation. *Med. Parazit. i Parazit. Bolezni* 28(4):443-447. In Rus., Engl. Sum.

KAUFMAN, H. E. and CALDWELL, L. A. 1959. Pharmacological studies of pyrimethamine (daraprim) in man. *Arch. Ophthalmology (A.M.A.)* 61(6):885-890.

YELLOW FEVER

BUSTAMANTE, M. E. 1958. La fiebre amarilla en México y su origen en América. *Inst. de Salubridad y Enferm. Trop.* (Mexico) Monogr. 2, 217 pp.

COLLIER, W. A., ROEVER-BONNET, H. DE and HOEKSTRA, J. 1959. A new intracerebral yellow fever mouse-protection test. *Trop. and Geog. Med.* 11(2):167-173.

———. 1959. Changed virulence of the yellow fever virus vaccine strain 17D by a single mouse passage. *Trop. and Geog. Med.* 11(1):75-79.

MACNAMARA, F. N., HORN, D. W. and PORTERFIELD, J. S. 1959. Yellow fever and other arthropod-borne viruses; a consideration of two serological surveys made in south western Nigeria. *Roy. Soc. Trop. Med. and Hyg. Trans.* 53(2):202-212.

MEERS, P. D. 1959. Combined smallpox-17D yellow fever vaccine for scratch vaccination. *Roy. Soc. Trop. Med. and Hyg. Trans.* 53(2):196-201.

LITERATURE REFERENCES AND REVIEWS

DUKHANINA, N. N. 1959. Native literature on problems of medical parasitology and parasitic diseases. A supplement for 1958 and the first

quarter of 1959. (Continued). *Med. Parazit. i Parazit. Bolezni* 28(4):489-497. In Rus.

SOLLERS, H. 1959. References to literature of interest to mosquito workers and malariologists. *Mosquito News* 19(3):211-219.

PUBLIC RELATIONS

KIMBALL, J. H. 1959. An educational approach to mosquito abatement via school curriculum. *Calif. Mosquito Cont. Assoc. Proc.* 27:55-56.

PAXTON, W. R. 1959. Public education and public relations from a newsman's point of view. *Calif. Mosquito Cont. Assoc. Proc.* 27:27-30.

LIGHT TRAP STUDIES

LOOMIS, E. C. and HANKS, S. G. 1959. Light trap indices of mosquito abundance: a comparison of operation for four and seven nights a week. *Mosquito News* 19(3):168-171.

MEYERS, E. G. 1959. Mosquito collections by light traps at various heights above ground. *Calif. Mosquito Cont. Assoc. Proc.* 27:61-63.

REED, D. E. 1959. Mosquito light trap captures without benefit of light. *Calif. Mosquito Cont. Assoc. Proc.* 27:63-66.

SUBJECTS NOT COVERED BY OTHER HEADINGS

BROWN, A. W. A. 1959. Report on a visit to eastern European countries, 20 May to 19 June 1959. *WHO/Insect/99*, 36 pp. [Data on mosquitoes included.]

CALIFORNIA MOSQUITO CONTROL ASSOCIATION. 1959. Year book. 37 pp.

EDDY, G. W. 1959. Highlights on U.S.D.A.'s research on mosquitoes in 1958. *Calif. Mosquito Cont. Assoc. Proc.* 27:84-86.

INSTITUTO DE MEDICINA TROPICAL (LISBOA). 1958. Número especial dedicado aos VI Congressos

Internacionais de Medicina Tropical e de Paludismo. *Inst. Med. Trop. An. (Lisboa)* 15 (Supl. No. 1):1-510.

JUIFFRE, S. C. 1959. Insurance for public agencies. *Calif. Mosquito Cont. Assoc. Proc.* 27:19-24.

KELLEN, W. R. 1959. Microbial control of vectors. *Calif. Vector Views* 6(6):35-38, 40. [Includes mosquitoes as vectors.]

KIMBALL, J. H. 1959. Principles of purchasing and procurement by mosquito abatement districts. *Calif. Mosquito Cont. Assoc. Proc.* 27:10-14.

MÜLLER, P. (Editor). 1959. DDT insecticides Vol. II. Human and veterinary medicine by Hayes, W. J., Jr., Simmons, S. W. and Knippling, E. F. 570 pp., Basel.

PAVLOVSKII, E. N. (Editor). 1958. Parasitological collection. 330 pp., Leningrad. In Rus. SHAWARBY, A. A. 1959. Training activities of the Insect Control Section. *Bul. Endemic Dis. (Baghdad)* 3(1/2):71-75.

VANNOTE, R. L. 1959. Wildlife from the mosquito control viewpoint. *Mosquito News* 19(3):199-200.

WORLD HEALTH ORGANIZATION. 1958. Proposed regular programme and budget estimates for the financial year 1 January-31 December 1960 with proposed programmes and estimates of expenditure under other available sources of funds. *WHO Off. Rec.* 89, 420 pp.

———. 1959. The work of WHO 1958, annual report of the Director-General. *WHO Off. Rec.* 90, 252 pp.

Errata

WORLD HEALTH ORGANIZATION. 1959. Corrigenda. *WHO/Mal/229*, Corr. 1, 1p., *WHO/Mal/226*, Corr. 1, 1 p.

In volume 19(3):214 of *Mosquito News*, section on Taxonomy, under Service, add 28(5/6) after Roy. *Ent. Soc. London Proc. (Ser. B.)*.

DESPLAINES VALLEY MOSQUITO ABATEMENT DISTRICT

8130 Ogden Avenue, Lyons, Illinois

Member of American Mosquito Control Association

Trustees

Otto McFeely, President; Charles F. Scheel, Vice-President; John J. Callahan, Secretary; Francis P. Creadon, Treasurer; William E. Goersmeyer, Ass't Secretary.

Franklin C. Wray, Technical Director

The District was created under state law adopted in 1927 by the General Assembly of Illinois. The District has functioned for thirty-two years.